PROHEAT®

M SERIES by TELEFLEX

SERVICE MANUAL

M50/M80/M105

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A. SAFETY

Throughout this manual, you will see notes labeled **DANGER**, **WARNING**, **CAUTION**, and **NOTICE** to alert you to special instructions or precautions concerning a particular procedure that would be hazardous if performed incorrectly or carelessly.

Observe them carefully!

These safety alerts alone, cannot eliminate hazards that can occur. Strict compliance with these special instructions when performing the installation and maintenance, plus common sense, are major accident prevention measures.

⚠ DANGER

Immediate hazards that will result in severe injury or death.

⚠ WARNING

Hazards or unsafe practices that could result in severe personal injury or death.

⚠ CAUTION

Hazards or unsafe practices that could result in minor injury or product or property damage.

NOTICE

Information that is important to proper installation or maintenance, but is not hazard-related.

SAFETY CONSIDERATIONS

⚠ WARNING

Exhaust

Inhalation of exhaust gas (containing carbon monoxide) may cause severe personal injury and/or death. Anyone suspected of suffering from CO inhalation should be removed from the hazardous area and given medical assistance immediately.

⚠ DANGER

California Proposition 65 Warning

Diesel exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Electrical components in this product may contain lead, a chemical known to the State of California to cause cancer and birth defects and other reproductive harm.

⚠ WARNING

Fuel

Exercise extreme caution when working near fuel or fuel-filled equipment. Do not operate equipment during fueling operations.

⚠ WARNING

Batteries

Use eye protection when working near batteries, which contain acid and can explode. Do not smoke or use open flames near batteries.

⚠ WARNING

Electrical

Electric shock can cause severe personal injury, burns, and death. Before working on any unit, disconnect the batteries. Use only approved materials and methods when working on the electrical system, and follow local electrical codes. Never work with electricity in wet conditions or when you are tired.

⚠ WARNING

Poisons/Toxins

Fuel and coolant are toxic and in some cases, carcinogenic. Wear eye and hand protection at all times. Remove contaminated clothing immediately and wash contaminated skin. Do not breathe in vapors.

⚠ WARNING

Hot Parts

Moving parts can cause severe injury and or death. Before working on any unit, shut it off. Do not operate any unit until protective covers have been replaced. Always ensure bolts and clamps are correctly torqued and secured. Inspect mechanical components periodically for damage and corrosion.

⚠ WARNING

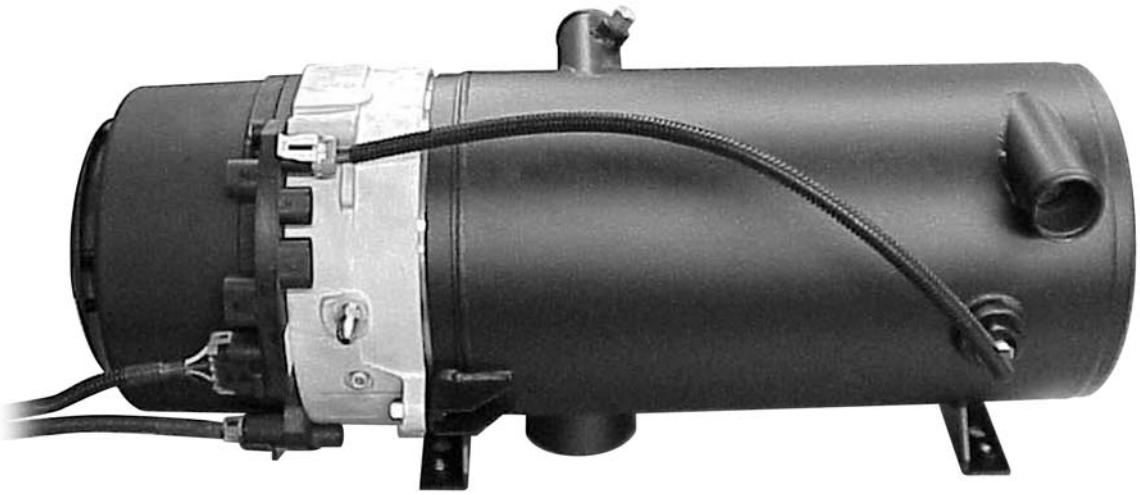
Coolant

Never remove the filler cap when the engine is hot – escaping steam or scalding water could cause serious personal injury. The coolant level in the expansion tank should be checked at least weekly (more frequently in high mileage or arduous conditions). Always check the level *when the system is cold*. Unscrew the filler cap slowly, allowing the pressure to escape before removing completely. Never run the engine without coolant.

Prevent anti-freeze coming in contact with the skin or eyes. If this occurs, rinse immediately with plenty of water. Anti-freeze will damage painted surfaces.

Never top-up with salt water. Even when travelling in territories where the water supply contains salt, always ensure you carry a supply of fresh (rain or distilled) water.

B. INTRODUCTION
MODEL: M50/M80/M105



This manual is provided to assist in troubleshooting and maintaining the PROHEAT M-Series heater. They are designed for use on any diesel-equipped vehicle including trucks, buses (school, transit and coach), construction equipment, off road equipment, military equipment and cargo.

PROHEAT heaters are used for the following applications:

(1) Engine Block Heat – A PROHEAT will preheat an engine block to ensure reliable starting in cold weather. Its' use throughout the year will reduce engine wear caused by cold starts.

(2) Supplemental Heat (engine running) – The PROHEAT can be used while the vehicle is operating to provide supplemental heat for the engine and/or passenger compartment.

(3) Cargo Heat – The PROHEAT can supply heat to individual compartments as a stand-alone heating system, or it can provide supplemental heat to an existing heating system.

(4) Marine – Marine applications typically involve the engineering and installation of a complete hot-water heating system of which PROHEAT is only one component. **Teleflex recommends that only an expert in marine hot-water heating systems install a PROHEAT for marine applications.**

NOTE: It is the installer's responsibility to ensure that an installation complies with all applicable codes and regulations.

1.0 TECHNICAL SPECIFICATIONS

	M50 12V	M50 24V	M80 12V	M80 24V	M105 24V
HEAT OUTPUT ± 10% BTU/hr (kW)	50,000 (15)	50,000 (15)	80,000 (23)	80,000 (23)	105,000 (30)
SYSTEM VOLTAGE Nominal Voltage (Range)	12 (10 – 15)	24 (20 – 30)	12 (10 – 15)	24 (20 – 30)	24 (20 – 30)
CURRENT DRAW Amps	9.5	4.0	8.5	4.0	7.5
FUEL CONSUMPTION US gph (lph)	0.48 (1.8)	0.48 (1.8)	0.78 (2.95)	0.78 (2.95)	1.04 (3.6)
IGNITION TYPE	Electronic Spark Ignition				
FUEL TYPES	Diesel, JP8, Jet A1, Arctic				
COOLANT OUTPUT TEMPERATURE MAX.	185°F (85°C)				
AMBIENT OPERATING TEMPERATURE	-40°F to +122°F (-40°C to +50°C)				
WEIGHT lbs (kg)	53 (23.5)				
HEAT EXCHANGER CAPACITY US gal (l)	0.5 (2)				
COOLANT SYSTEM					
Minimum Capacity US gal (l)	2.64 (10)	2.64 (10)	2.64 (10)	2.64 (10)	2.64 (10)
Recommended Flow Rate Through Heater US gpm (lpm)	5 (19)	5 (19)	7 (26.5)	7 (26.5)	9 (34)

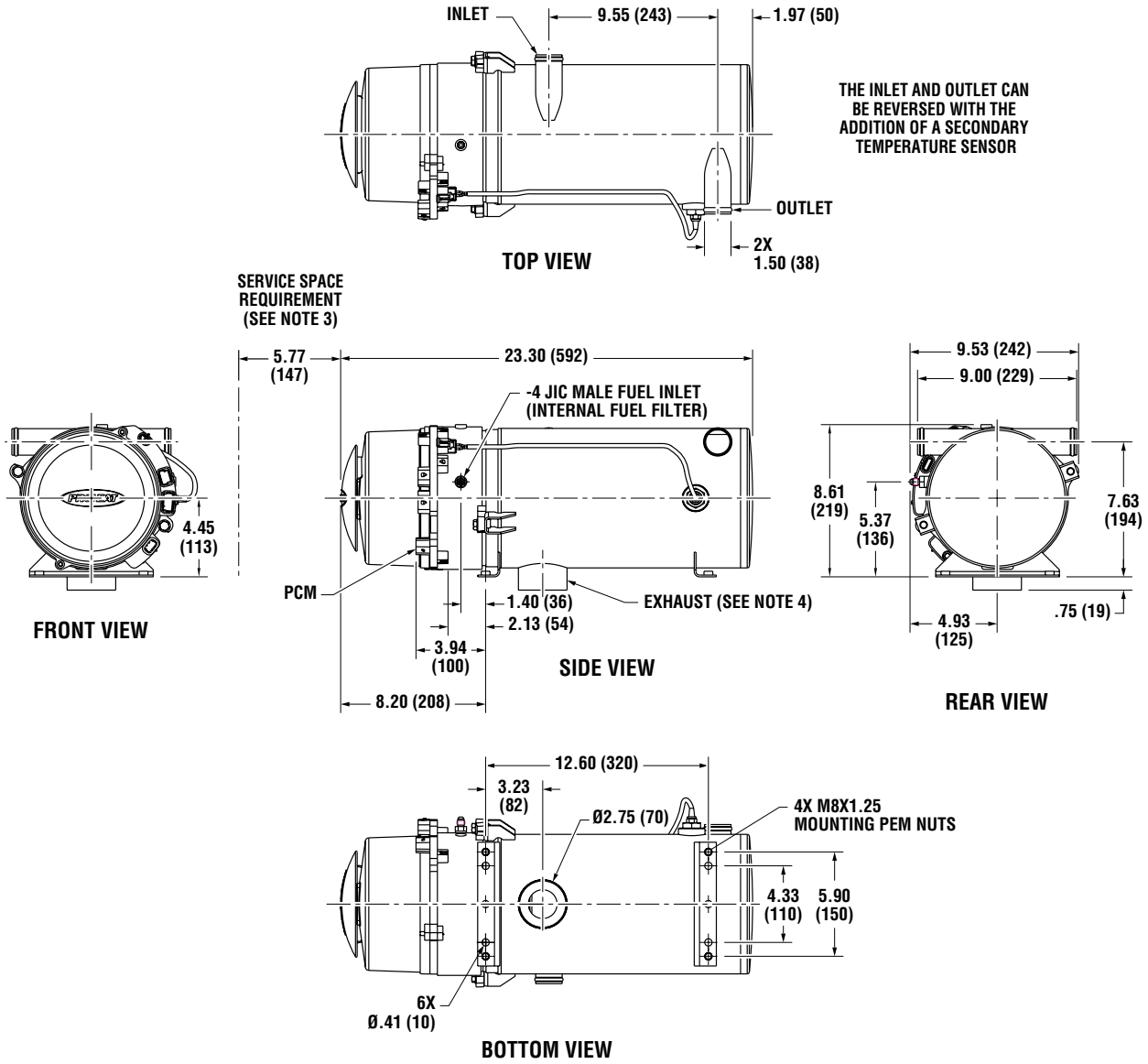
⚠ DANGER

Do not use gasoline.

SYSTEM OUTPUTS	
AUXILIARY OUTPUT	Same as System Voltage Maximum 1 Amp draw (over-load shut-off protection) High-side switched
SWITCH/TIMER POWER	Same as System Voltage Maximum 1 Amp draw (over-load shut-off protection) High-side switched
COOLANT PUMP	Same as System Voltage Maximum 10 Amp draw (over-load shut-off protection) High-side switched
INDICATOR LIGHT	Same as System Voltage Maximum 1 Amp draw (over-load shut-off protection) High-side switched

SYSTEM INPUTS	
SWITCH	10 – 30V Standard Run Mode Preheat Run Mode Supplemental Run Mode
COOLANT PUMP AUXILIARY	10 – 30V Allows independent operation of Coolant Pump through the Proheat Control Module

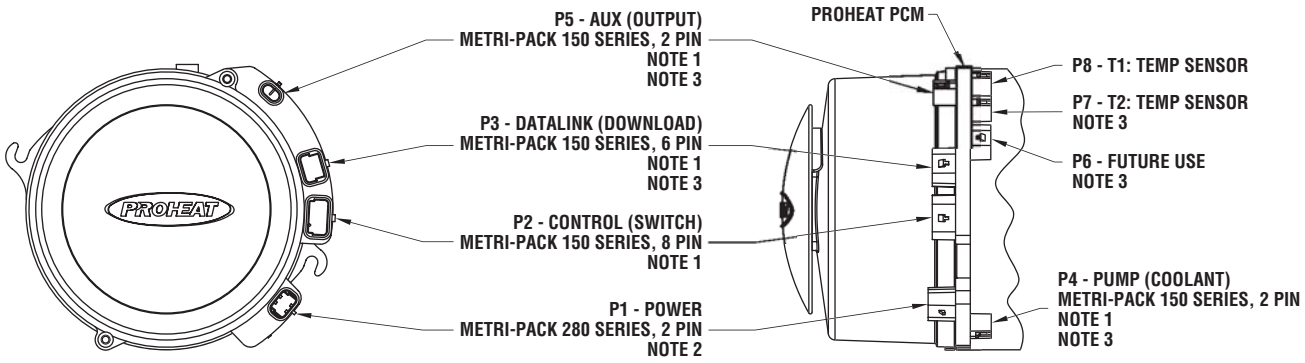
1.1 PHYSICAL

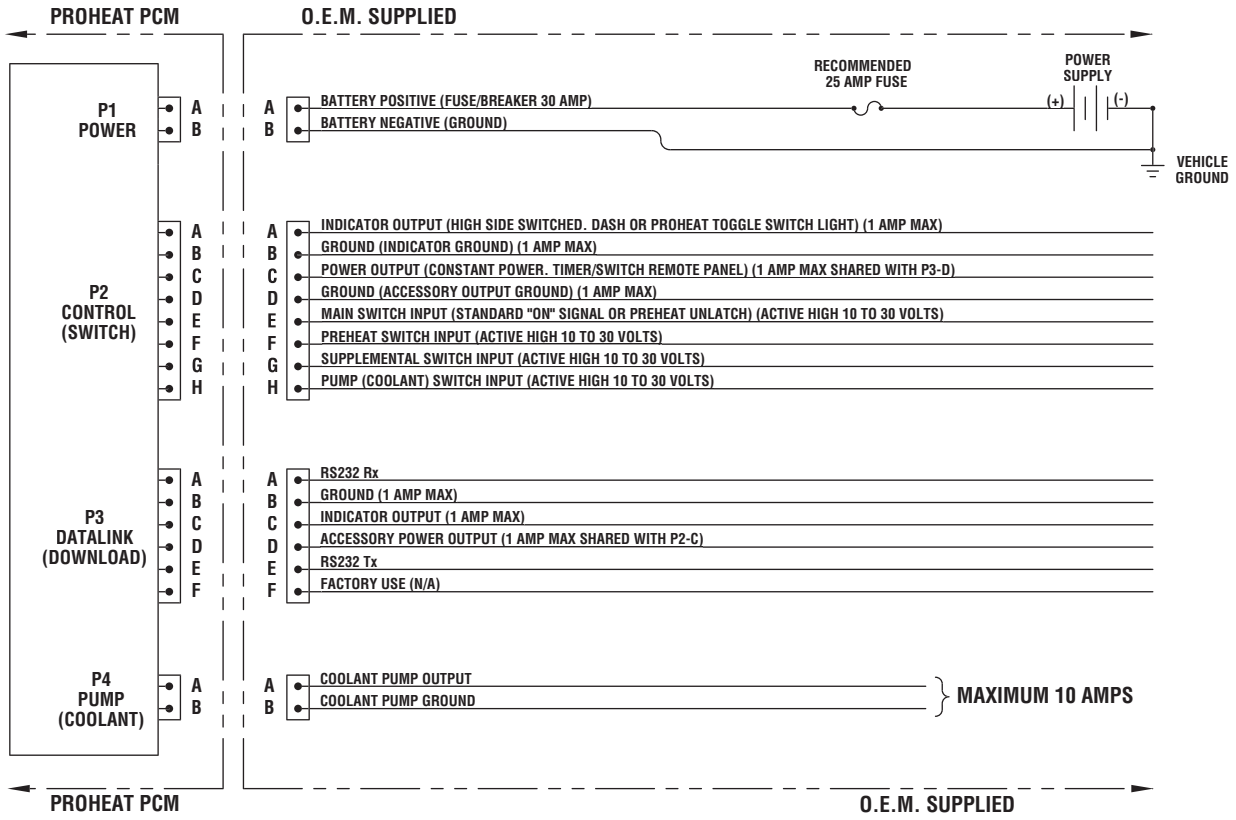


NOTES:

1. DIMENSIONS ARE IN INCHES (MILLIMETERS IN BRACKETS).
2. TYPICAL EXHAUST CUTOUT 3.25" CENTERED ON EXHAUST.
3. SERVICE SPACE REQUIRED TO REMOVE BURNER HEAD AND COMBUSTION TUBE FOR PERIODIC INSPECTION AND CLEANING.
4. THE EXHAUST PIPE SHOULD HAVE A MINIMUM DIAMETER OF 2.75", A MAXIMUM LENGTH OF 5' AND HAVE NO MORE THAN 180 DEGREES OF BENDS.

1.2 ELECTRICAL




PROHEAT PCM
O.E.M. SUPPLIED
P1 POWER
A
B
BATTERY POSITIVE (FUSE/BREAKER 30 AMP)
BATTERY NEGATIVE (GROUND)
RECOMMENDED 25 AMP FUSE
POWER SUPPLY
(+)
(-)
VEHICLE GROUND
P2 CONTROL (SWITCH)
A INDICATOR OUTPUT (HIGH SIDE SWITCHED. DASH OR PROHEAT TOGGLE SWITCH LIGHT) (1 AMP MAX)
B GROUND (INDICATOR GROUND) (1 AMP MAX)
C POWER OUTPUT (CONSTANT POWER. TIMER/SWITCH REMOTE PANEL) (1 AMP MAX SHARED WITH P3-D)
D GROUND (ACCESSORY OUTPUT GROUND) (1 AMP MAX)
E MAIN SWITCH INPUT (STANDARD "ON" SIGNAL OR PREHEAT UNLATCH) (ACTIVE HIGH 10 TO 30 VOLTS)
F PREHEAT SWITCH INPUT (ACTIVE HIGH 10 TO 30 VOLTS)
G SUPPLEMENTAL SWITCH INPUT (ACTIVE HIGH 10 TO 30 VOLTS)
H PUMP (COOLANT) SWITCH INPUT (ACTIVE HIGH 10 TO 30 VOLTS)
P3 DATALINK (DOWNLOAD)
A RS232 Rx
B GROUND (1 AMP MAX)
C INDICATOR OUTPUT (1 AMP MAX)
D ACCESSORY POWER OUTPUT (1 AMP MAX SHARED WITH P2-C)
E RS232 Tx
F FACTORY USE (N/A)
P4 PUMP (COOLANT)
A COOLANT PUMP OUTPUT
B COOLANT PUMP GROUND
MAXIMUM 10 AMPS
PROHEAT PCM
O.E.M. SUPPLIED

PCM CONNECTOR	CONNECTOR PART#	LOCK PART#	TERMINAL PART#	WIRE SEAL PART#	CAVITY SEAL PART#
P1-POWER	15300027	15300014	12077413	12015193	----
P2-CONTROL (SWITCH)	12047937	12066304	12048074	12048086	12059168
P3-DATALINK (DOWNLOAD)	12052848	12052850	12048074	12048086	12059168
P4-PUMP (COOLANT)	12052641	12052634	12048074	12048086	12059168

NOTES:

1/ 150 SERIES CONNECTOR ASSEMBLIES TO BE USED WITH 18AWG WIRE WITH MAXIMUM .1" INSULATION DIAMETER. WIRE MUST MEET OR EXCEED SAE J1128 GPT SPECIFICATIONS.

2/ 280 SERIES CONNECTOR ASSEMBLIES TO BE USED WITH 10AWG WIRE WITH MAXIMUM .161" INSULATION DIAMETER. WIRE MUST MEET OR EXCEED SAE J1128 GPT OR GXL.

3/ ALL UNUSED CONNECTIONS ON THE PCM ARE SUPPLIED WITH SEAL PLUGS ON STANDARD HEATERS.

2.0 PRINCIPLE OF OPERATION

2.1 COMPONENT DESCRIPTIONS

Combustion Air Blower: Impeller-style blower driven by the Motor provides the principle combustion air.

Motor: Drives the Combustion Air Blower, Air Compressor and Fuel Supply Pump.

Fuel Supply Pump: A positive displacement, gear-type pump that draws fuel from the vehicle fuel tank and supplies it to the Fuel Regulator. Pressure is regulated between 7 – 10 PSI by means of an internal relief valve. Fuel is re-circulated within the pump, therefore a fuel return line to the tank is not required.

Fuel Regulator: Diaphragm-type pressure reducing valve. The Fuel Regulator drops the fuel supply pressure to atmospheric pressure (0 PSI).

Fuel Nozzle: Air-aspirating type burner nozzle. Compressed air flows through the air passages, exiting the nozzle in front of the fuel orifice creating a vacuum in the fuel supply. This draws fuel from the Fuel Regulator and the combined fuel/air mixture is atomized into the combustion chamber.

Fuel Shut-off Valve: Electrically operated solenoid valve which controls fuel flow to the Fuel Nozzle.

Air Compressor: Rotary vane compressor that supplies air pressure (in the range of 3 – 5 PSI) to the Fuel Nozzle.

Ignition Module: Electronic Ignition Module with plug-in electrode.

PCM: (PROHEAT Control Module) Electronic control module monitors the PROHEAT sensors, operating conditions, and controls the Motor and other devices. Diagnostics are utilized for both safety in operations and detection of component faults to aid in service and troubleshooting. The PCM contains the flame sensor which senses the flame intensity. This information can be retrieved by a personal computer using PROHEAT Datalink software.

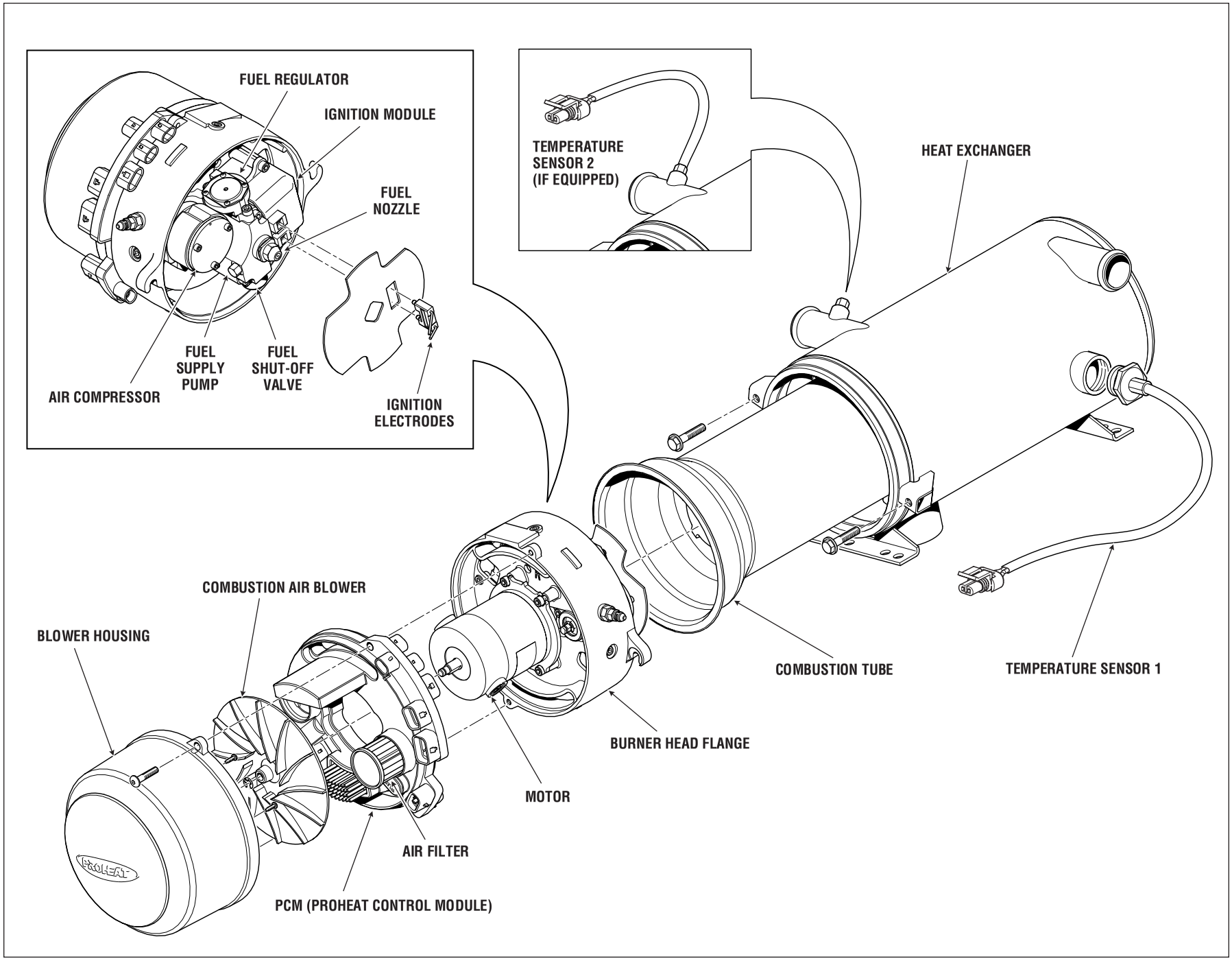
Combustion Tube: Directs the air supplied by the blower through a swirler into the combustion zone, mixing it with the atomized fuel/air mixture from the Fuel Nozzle.

Heat Exchanger: Coolant is circulated through the heat exchanger via the inlet and outlet ports. Heat is transferred from the heat exchanger through the inner wall of the exchanger into the coolant. The exhaust gases are directed out through the exhaust port.

Temperature Sensor 1: Measures the coolant temperature near the outlet port of the heat exchanger and sends this information to the PCM. **It must be connected at all times for overheat protection.**

Temperature Sensor 2: For installations where the coolant flow through the heat exchanger is opposite of what is specified on page 1-2. This sensor also measures the inner heat exchanger surface temperature for an overheat condition.

Coolant Pump: Circulates coolant through the PROHEAT and vehicle heating system. Depending on the PROHEAT installation, it may be operated by the PCM.


FUEL REGULATOR
IGNITION MODULE
FUEL NOZZLE
AIR COMPRESSOR
FUEL SUPPLY PUMP
FUEL SHUT-OFF VALVE
IGNITION ELECTRODES
TEMPERATURE SENSOR 2 (IF EQUIPPED)
HEAT EXCHANGER
COMBUSTION AIR BLOWER
BLOWER HOUSING
COMBUSTION TUBE
TEMPERATURE SENSOR 1
BURNER HEAD FLANGE
MOTOR
AIR FILTER
PCM (PROHEAT CONTROL MODULE)
PROHEAT

2.2 NORMAL OPERATING SEQUENCE

1. . . . . Switch On: If the coolant temperature is below 160°F (71°C) the PROHEAT enters **Pre-check.** If the coolant temperature is above 160°F (71°C) the PROHEAT enters **Standby**.

2. . . . . Pre-check: The PCM performs self diagnosis checking sensors for correct range and electrical components for over-load. Also during the first **Pre-check**, the Ignition Module is powered for five seconds to allow a service technician to visually check for a spark.

3. . . . . Ignition: The Motor and Coolant Pump start first, followed by the ignition spark, and Fuel Shut-off Valve. The Ignition Module sparks for 30 seconds during which time the flame sensor must detect correct combustion.

4. . . . . Combustion Check: At the end of the **Ignition** cycle the Flame Sensor checks the combustion. If acceptable, the PROHEAT enters **Full Output**. If not acceptable, the PROHEAT goes to **Cool Down** and then will start again at **Pre-check**. If the second start cycle fails the PROHEAT will enter **Fault Shut Down**.

5. . . . . Full Output: The PROHEAT will continue in **Full Output** until the coolant temperature reaches 185°F (85°C) at the PROHEAT outlet Temperature Sensor.

6. . . . . Cool Down: The Motor and Coolant Pump continue to operate for up to three minutes, the Motor stops and the PROHEAT enters **Standby**. The PROHEAT will **Cool Down** for three reasons:

- Coolant reaches 185°F (85°C).
- A fault is detected. *Go to Troubleshooting and Repair*
- The PROHEAT is operating in **Ignition** or **Full Output** when it is switched off.

7. . . . . Standby: The Coolant Pump continues to circulate coolant throughout the system *(go to Auxiliary Input Section for alternative operating modes)*. When the coolant temperature drops to its cycle on temperature, the PCM will repeat the cycle starting at **Pre-check**.

8. . . . . Switch Off: If the PROHEAT is in **Ignition** or **Full Output**, it will **Cool Down** first, then shut OFF. If the PROHEAT is in **Standby**, it will shut OFF immediately.

9. . . . . Fault Shut Down: If the PROHEAT diagnostics sense a system or component fault, the PROHEAT will shut down all components and flash a fault code(s) which best represents the conditions. To reset the PROHEAT, it must be switched off and then on again.

NOTE: Damage may occur it the fault codes are ignored and the PROHEAT is repeatedly switched off and on without addressing the problem.

3.0 TROUBLESHOOTING AND REPAIR

Problems with the PROHEAT and its operation will be indicated in two ways:

1. PROHEAT Diagnostic Faults indicated by means of a flashing diagnostic code on an indicator light (if equipped). *Go to page 3-2.*
2. Operational problems may not be identified with a flashing diagnostic code (e.g., blown fuse, obstructed coolant flow, air leaks in fuel supply line). *Go to page 3-40*.

Troubleshooting a Problem

STEP 1 Locate the PROHEAT, remove the enclosure lid if used and visually check for any problems with wiring harnesses, fuel leaks, coolant leaks, exhaust pipe damage and environmental condition.

STEP 2 If equipped with a diagnostic indicator light, and it is flashing, determine the code based on *page 3-2.*

STEP 3 If no code is indicated, turn the PROHEAT off and then on again using the existing operational switches, timer or a PROHEAT remote start switch (PROHEAT P/N PK0091).

STEP 4 Let the PROHEAT attempt to start and/or operate. Observe the operation.

NOTE: The PROHEAT will always attempt to start twice, as long as the coolant temperature is below 160°F (71°C). If a fault is detected it will shut down, go through a **Cool Down** and attempt a second start. After both attempts to start or operate, an indicator light will flash a diagnostic code. *Go to page 3-2.*

- If the indicator light flashes, count the number of flashes and refer to the troubleshooting diagnostic code description for that number on the following pages.
- If the PROHEAT runs but is not performing or operating correctly, *consult the Operational Problems section, page 3-40.*

Troubleshooting and Repair Tools Required

- **Remote Start Switch** (PROHEAT P/N PK0091)
  Allows the service technician to work at the PROHEAT. Isolates the PROHEAT from the existing vehicle system controls and comes with a built-in indicator light.
- **Temperature Sensor** (PROHEAT P/N 200301K)
  Allows the service technician to start a PROHEAT when the coolant temperature is greater than 160°F (71°C). To be used only for troubleshooting.

3.1 SYSTEM AND COMPONENT DIAGNOSTICS

The PCM continually monitors the PROHEAT operating conditions. If the PCM detects a problem, the indicator light flashes a diagnostic code(s).

The diagnostic indicator light may be located:

- In the toggle of the ON/OFF Switch provided by PROHEAT (standard installation kit).
- In the PROHEAT Timer manual ON light (red).
- In an OEM indicator light package.
- In the remote switch (PROHEAT P/N PK0091) used for troubleshooting.

	NO. OF FLASHES	DIAGNOSTIC CODE DESCRIPTION	PAGE
SYSTEM DIAGNOSTICS	1	Start	3-3
	2	Flame Out	3-24
	3	Coolant Flow	3-25
	4	Overheat	3-27
	5	Voltage	3-27
	6	Flame Fault	3-29
COMPONENT DIAGNOSTICS	7	Temperature Sensor T1	3-29
	8	Fuel Shut-off Valve	3-31
	9	Temperature Sensor T2	3-32
	10	Ignition Module	3-32
	11	Coolant Pump	3-33
	12	Motor	3-34
	13	Auxiliary Output	3-35
	14	Switch Output	3-36

3.1.1 START Diagnostic Code

(1 Flash)

Indicates that the PCM Flame Sensor did not detect a flame or the flame was too weak to be detected during the FULL ignition period (M50/M80/M105 – 30 second ignition period).

Troubleshoot the Start diagnostic code based on the following symptoms:

1. **Fuel System.** *Go to page 3-4 to 3-15, Steps 1 through 7.*
   a) There is no fuel, fuel odor or atomized fuel coming from the exhaust pipe.
   b) There is no hot exhaust coming from the exhaust pipe.
2. **Ignition System.** *Go to page 3-18.*
   a) There is raw fuel and/or atomized fuel and a raw fuel odor coming from the exhaust pipe.
   b) There is no hot exhaust coming from the exhaust pipe.
3. **PCM (PROHEAT Control Module) Flame Sensor circuit.** *Go to page 3-20.*
   a) There is a flame and the combustion sounds good, the PROHEAT appears to be operating normally.
   b) No smoke, raw fuel odor or atomized fuel is coming from the exhaust pipe.
4. **Motor and/or PCM fault.** *Go to page 3-22.*
   a) The Motor is NOT running. Ignition and Coolant Pump are operating.
   b) No smoke, raw fuel odor or atomized fuel coming from the exhaust pipe.

START: Fuel System Step 1

(1 Flash)

Fuel and fuel supply – Check:

a) Vehicle fuel level and/or for fuel gelling during cold weather.

b) Air leaks and/or restrictions in the fuel supply lines to the PROHEAT.

c) The PROHEAT operation when supplying fuel from a direct source.

Test Procedure – Supplying fuel from a remote source:

a) Remove the fuel supply line from the PROHEAT fuel inlet.

b) Using a length of fuel line connected from the PROHEAT fuel inlet to a direct source of CLEAN fuel. Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If the PROHEAT functions correctly, the fault is in the vehicle fuel system. Check fuel lines, connections and routing back to fuel tank. Consult OEM for service requirements.

If a Start diagnostic code is indicated, the problem is in the PROHEAT fuel system. Proceed to Step 2.

NOTICE

When fuel system is open, the PROHEAT will smoke and stumble until the air is purged from the system. It may be required to cycle more than one time.

⚠ WARNING

Flammable.

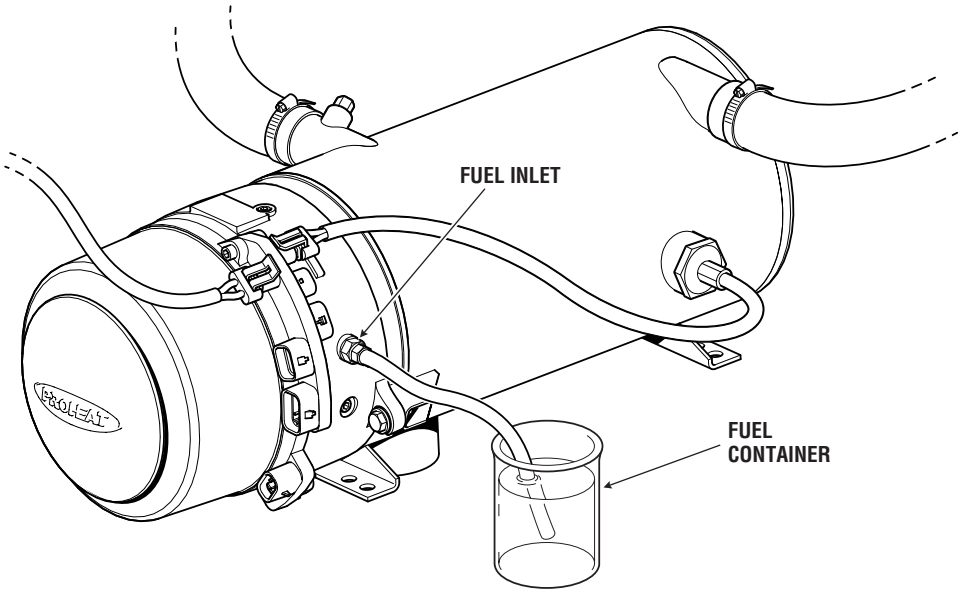


Figure 3-1: Remote Fuel Supply

START: Fuel System Step 2

(1 Flash)

PROHEAT fuel filter – Check:

a) For filter contamination and restrictions.

b) For damaged inlet fitting.

⚠ WARNING

Flammable.

Test Procedure – Fuel filter inspection, cleaning and/or replacement:

a) Disconnect the fuel supply line at the PROHEAT.

b) Remove the fuel filter adapter and fuel inlet fitting located in the burner head.

c) Remove O-ring and filter. Inspect for contamination and/or restrictions. Clean filter using electrical contact cleaner, brake cleaner or warm soapy water. Replace if necessary.

d) Inspect the O-rings for contamination and/or damage. Clean O-rings with a cloth or replace as necessary.

e) Inspect and clean the filter cavity and O-ring seat as necessary using contact or brake cleaner.

f) Reinstall filter, O-rings and inlet adapter. Tighten the adapter until it bottoms out against the face.

g) Reconnect the fuel supply line.

h) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If a Start diagnostic code is indicated, proceed to Step 3.

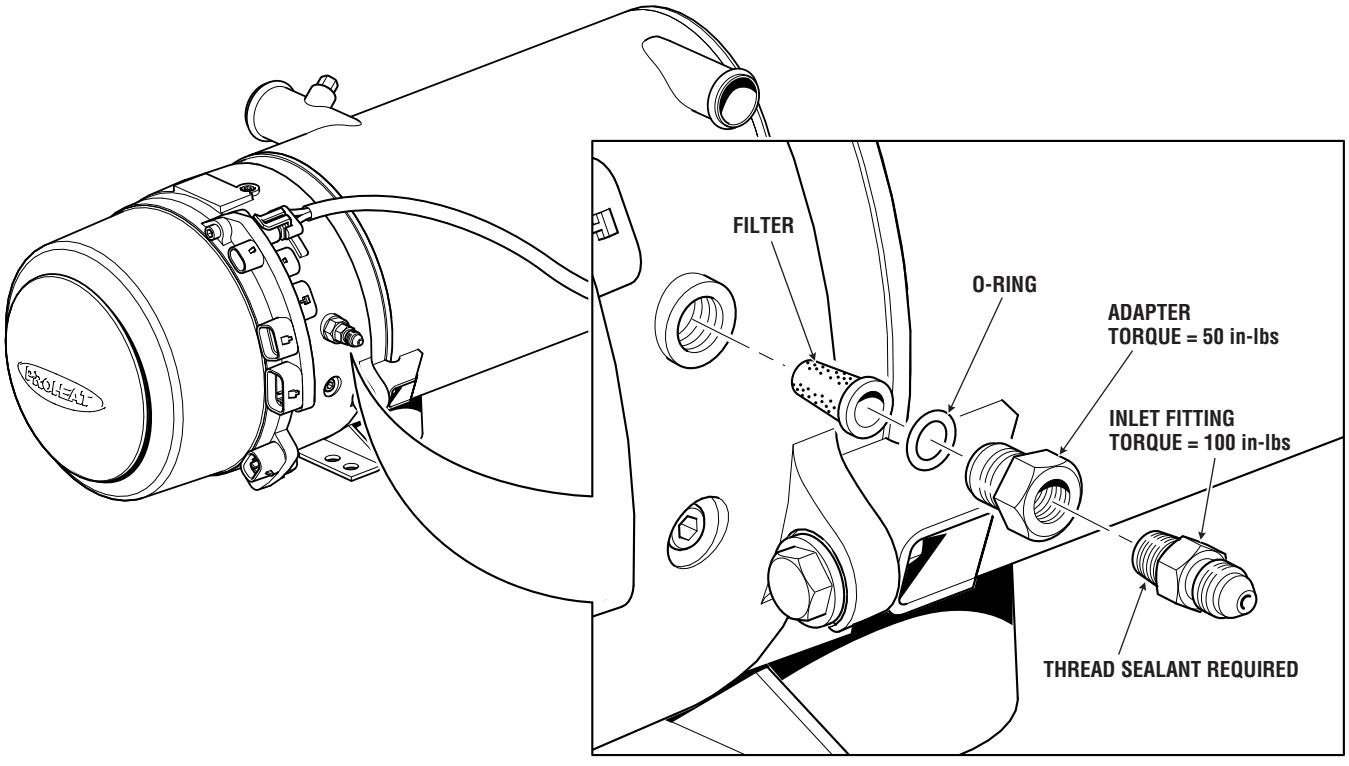


Figure 3-2: Fuel Filter Assembly and Location

START: Fuel System Step 3

(1 Flash)

Fuel Nozzle and Fuel Nozzle cavity – Check:

a) For Fuel Nozzle and O-ring damage and/or contamination.

b) For correct Fuel Nozzle for the PROHEAT BTU rating.

Test Procedure – Fuel Nozzle removal, inspection and cleaning or replacement:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Remove Fuel Nozzle. Verify the Fuel Nozzle number ensuring it is the correct Fuel Nozzle for your PROHEAT model. *See table below.*

MODEL	NUMBER
M50	30609-50
M80	30609-9
M105	30609-11

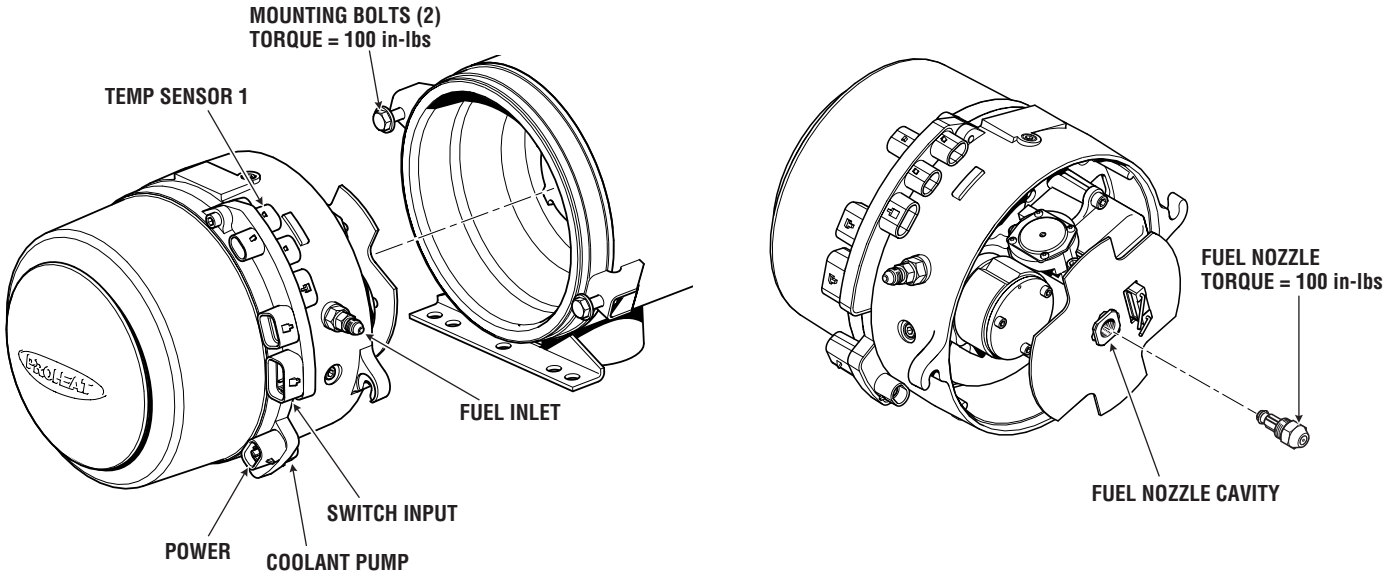


Figure 3-3: Burner Head Removal and Fuel Nozzle Removal

NOTICE

Fuel Nozzle parts are a matched set and not interchangeable.

e) Disassemble, inspect, clean, and reassemble Fuel Nozzle.

Fuel Nozzle disassembly, inspection, cleaning and reassembly:

- Hold the Fuel Nozzle stem lightly but firmly in a vise, take care not to cause damage. Disassembles in three pieces.
- Inspect Fuel Nozzle stem and O-ring for contamination and/or damage. Inspect and clean distributor fuel orifice, air passages, head and stem with electrical contact cleaner, brake cleaner or warm soapy water.

- Re-clamp the Fuel Nozzle stem lightly but firmly in a vise, take care not to cause damage. Reinstall the distributor and Fuel Nozzle head. Ensure that the distributor is seated correctly. The Fuel Nozzle assembly is self-aligning.

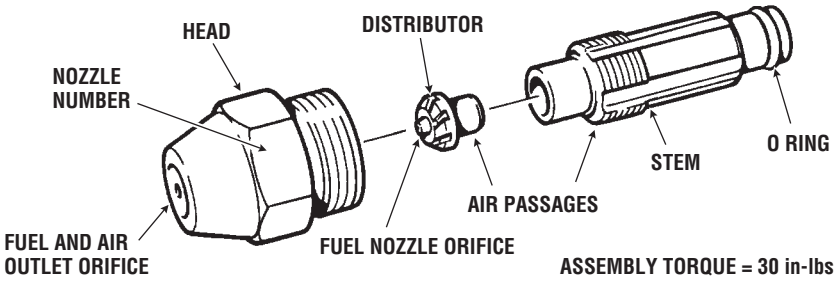


Figure 3-4: Fuel Nozzle Assembly

f) Inspect the Fuel Nozzle cavity and clean as necessary using electrical contact cleaner or brake cleaner.

g) Reinstall the Fuel Nozzle.

h) Reinstall the burner head by mounting it against the heat exchanger face, turning clockwise to engage the mounting ears on the bolts.

i) Tighten mounting bolts.

j) Reconnect the electrical harnesses and fuel supply line.

k) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If a Start diagnostic code is indicated, proceed to Step 4.

START: Fuel System Step 4

(1 Flash)

Fuel Shut-off Valve – Check:

a) Fuel Shut-off Valve and PCM - electrical open circuit fault.

b) Valve plunger – mechanical fault. Test the PROHEAT operation; Fuel Shut-off Valve plunger removed.

NOTICE

It is recommended that the Fuel Regulator be serviced at the same time as the Fuel Shut-off Valve. *Go to page 3-11, Step 5.*

Procedure – Coil and PCM – electrical fault:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

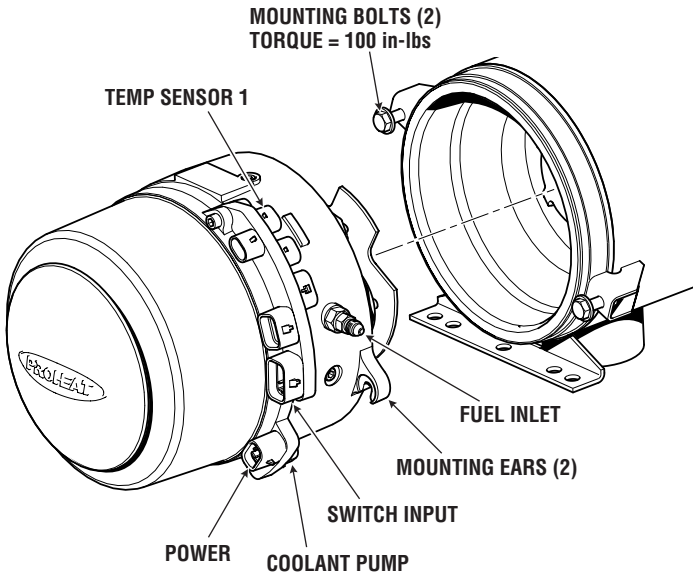


Figure 3-5: Burner Head Removal

d) Remove the Fuel Shut-off Valve connector. Use a small flat head screwdriver to lift the connector locking tab, pulling up on the connector to remove.

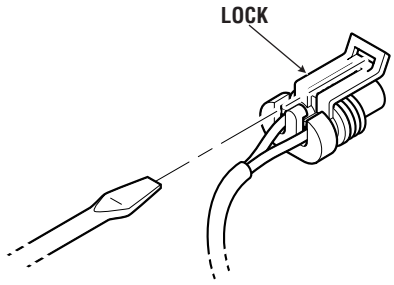


Figure 3-6: Connector Removal

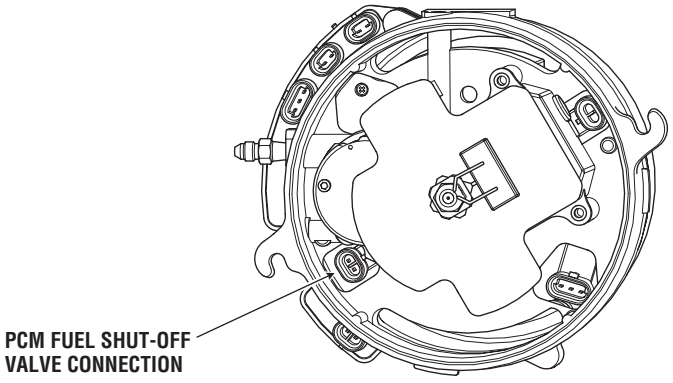


Figure 3-7: PCM Fuel Shut-off Valve Connection

⚠ WARNING

Shock hazard due to high voltage.

e) Measure the Fuel Shut-off Valve coil using a multimeter set to read Ohms.

If the coil measures between 35 and 45 Ohms, coil is OK. Go to:

- *Fuel Shut-off Valve output voltage measurement.*
- *Procedure – Fuel Shut-off Valve – Mechanical function.*

If the coil measures open circuit, coil is faulty. Replace the Fuel Shut-off Valve. Go to Fuel Shut-off Valve replacement, page 3-10.

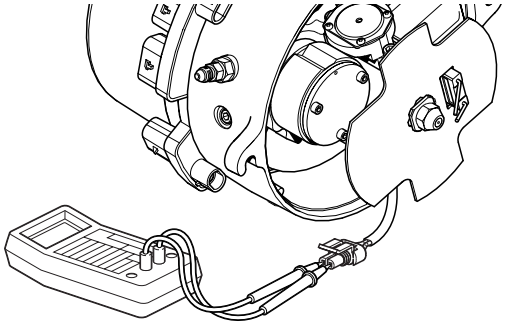


Figure 3-8: Coil Electrical Resistance Measurement

Fuel Shut-off Valve output voltage measurement:

⚠ WARNING

To avoid the risk of shock and to ensure that the PROHEAT does not fire, disconnect the Ignition Module connector at the PCM.

NOTICE

All PROHEAT external harnesses must be connected to ensure that the PROHEAT attempts to start after Pre-check.

a) Reconnect the power, Temperature Sensor(s) and switch harnesses at the PCM.

b) Disconnect Ignition Module connector at the PCM.

c) Switch the PROHEAT on and measure across pins A and B of the PCM Fuel Shut-off Valve connection.

If no voltage is measured, the PCM is faulty. Go to PCM replacement, page 3-39.

If the correct voltage (9 – 15 V) is measured, the PCM is OK. Go to Procedure – Fuel Shut-off Valve – Mechanical function.

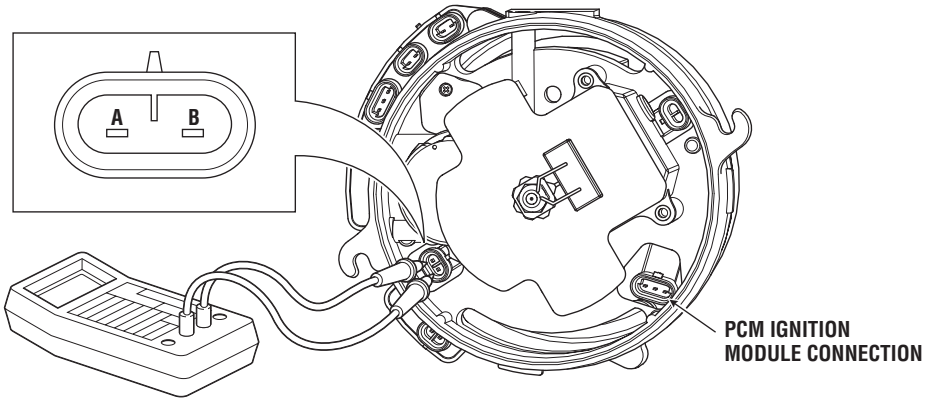


Figure 3-9: PCM Fuel Shut-off Valve Output Voltage Measurement

Procedure – Fuel Shut-off Valve – Mechanical function:

a) Using a flat head screwdriver hold the valve stem while loosening the coil nut. Remove the coil.

b) Loosen and remove the valve stem. Remove the O-ring, plunger and spring. Save the parts.

c) Inspect the O-ring and plunger seat for contamination. Clean as necessary using electrical contact cleaner or brake cleaner. Reinstall the valve stem and seal. DO NOT INSTALL THE PLUNGER AND SPRING.

d) Reinstall the coil, coil nut and reconnect the Fuel Shut-off Valve to the PCM.

e) Reinstall the burner head by mounting it against the heat exchanger face, turning clockwise to engage the mounting ears on the bolts.

f) Reconnect electrical harnesses and fuel supply line.

g) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If the PROHEAT runs OK, the Fuel Shut-off Valve is faulty. Go to Fuel Shut-off Valve replacement.

If a Start diagnostic code is indicated, proceed to Step 5.

⚠ WARNING

Flammable.

Fuel Shut-off Valve replacement:

a) Using a flat head screwdriver, hold the stem in place while loosening the coil nut. Remove the coil.

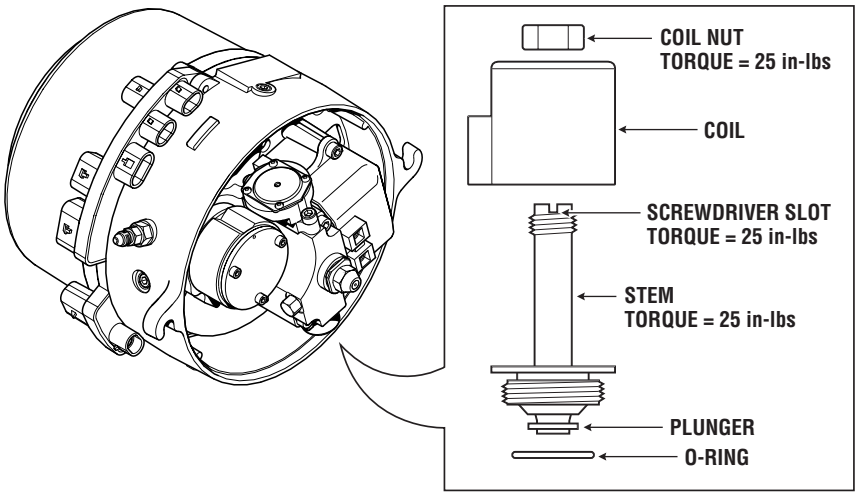


Figure 3-10: Fuel Shut-Off Valve Assembly

b) Loosen and remove the valve stem. Remove the O-ring, plunger and spring.

c) Inspect the O-ring and plunger seat in the fuel block for contamination. Clean as necessary using electrical contact cleaner or brake cleaner.

d) Install the new valve stem and seal using a slot screwdriver.

e) Reinstall the coil, coil nut and reconnect the Fuel Shut-off Valve connector at the PCM.

f) Reinstall the burner head by mounting it against the heat exchanger face, turning clockwise to engage the mounting ears on the bolts.

g) Reinstall electrical harnesses and fuel supply line.

h) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

START: Fuel System Step 5

(1 Flash)

Fuel Regulator – Check:

a) For damage and/or contamination and mechanical operation.

Procedure – Fuel Regulator removal, inspection and reinstallation:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Remove ignition electrode assembly. Use a flat head screwdriver to pry the electrode assembly out.

⚠ WARNING

Flammable.

e) Remove the flame shield. Rotate to match the mounting square.

f) Remove the Fuel Regulator (2) screws, Fuel Regulator and O-rings.

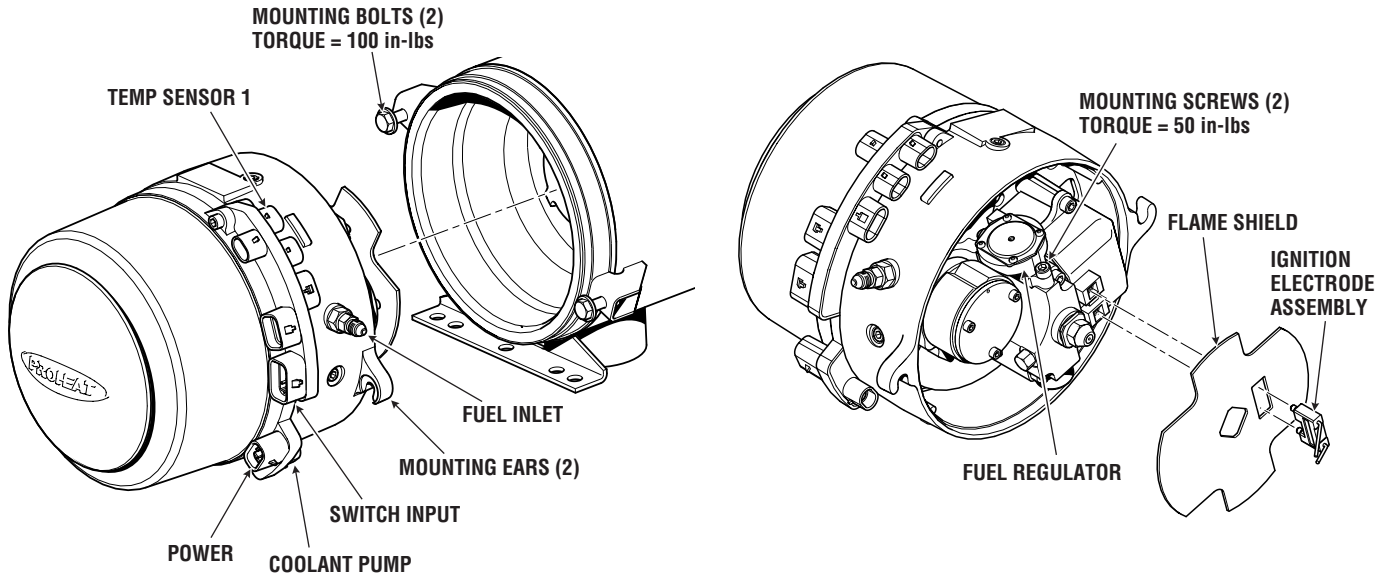


Figure 3-11: Burner Head Removal and Fuel Regulator Removal

g) Inspect O-rings and O-ring seats for contamination and/or damage. Replace if necessary.

h) Reinstall regulator ensuring that the O-rings are seated properly.

i) Reinstall the burner head by mounting it against the heat exchanger face, turning clockwise to engage the mounting ears on the bolts.

j) Reconnect the electrical harnesses and fuel supply line.

k) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If a Start diagnostic code is indicated, proceed to Step 6.

START: Fuel System Step 6

(1 Flash)

Air Compressor – Check:

a) Air Compressor pressure and operation.

Before checking air pressure, remove, disassemble and clean Fuel Nozzle. Go to Fuel Nozzle disassembly, inspection, cleaning and reassembly, page 3-6.

⚠ WARNING

To avoid the risk of shock and to ensure that the PROHEAT does not fire, disconnect the Ignition Module connector at the PCM.

NOTICE

Leaving the Temperature Sensor(s) disconnected ensures that the burner head will only run in purge for a maximum of three minutes. It will not try to fire up.

Test Procedure – Air Compressor pressure:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Remove ignition electrode assembly. Use a flat head screwdriver to pry the electrode assembly out.

e) Remove the flame shield. Rotate to match the mounting square.

f) Disconnect the Fuel Shut-off Valve and Ignition Module connectors at the PCM. This ensures that fuel will not spray and/or light during testing.

g) Remove the Air Compressor test port plug and install pressure test gauge.

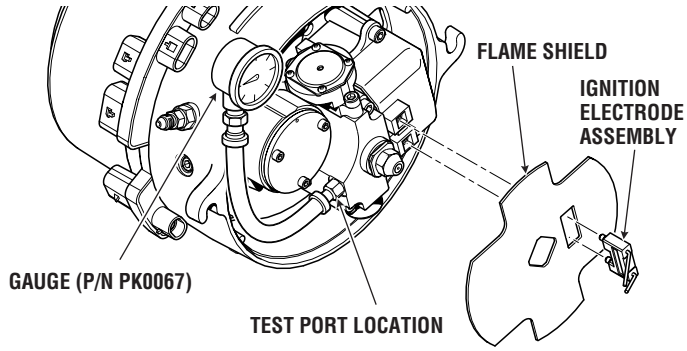


Figure 3-12: Air Pressure Test

h) Reconnect the power and switch harnesses at the PCM.

i) Switch the PROHEAT on and read the air pressure:

If the Air Compressor reading is out of range, go to Air Compressor filter check before attempting adjustment.

If the Air Compressor filter is clean, adjust the PSI ouput as per table below. If the Air Compressor cannot be set to the correct PSI output, replace Air Compressor. Go to Air Compressor removal and reinstallation, page 3-13.

If a Start diagnostic code is indicated, proceed to Step 7.

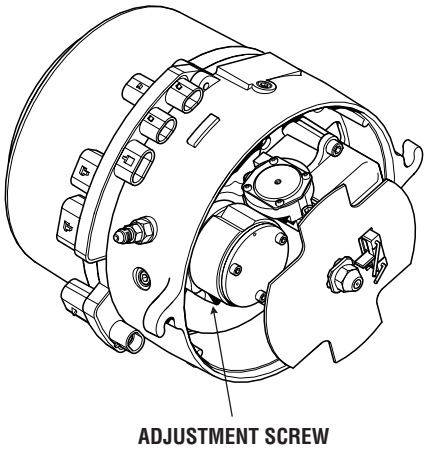


Figure 3-13: Air Compressor Adjustment

MODEL	AIR PRESSURE BAR (PSI)
M50	0.42 ± 0.01 bar (6.2 ± 0.2 PSI)
M80	0.22 ± 0.01 bar (3.2 ± 0.2 PSI)
M105	0.26 ± 0.01 bar (3.8 ± 0.2 PSI)

Air Compressor filter check:

a) Remove blower housing (2) screws and blower housing.

b) Remove the Air Compressor filter. Inspect for contamination and replace if necessary.

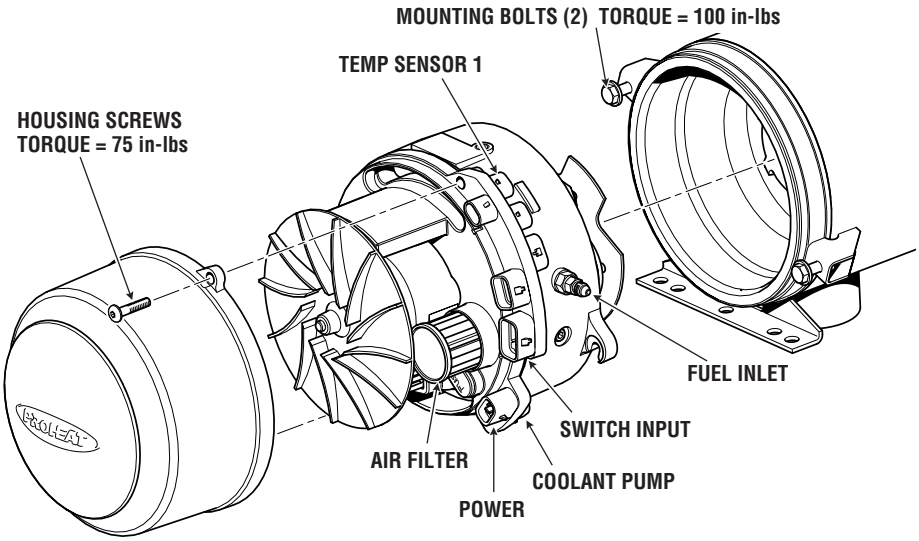


Figure 3-14: Burner Head and Blower Housing Removal

Air Compressor removal and reinstallation:

a) Disconnect Motor, Fuel Shut-off Valve and Ignition Module connectors at the PCM.

b) Remove blower housing (2) screws and blower housing.

c) Remove blower retaining snap ring and slide the blower off the Motor shaft.

d) Remove the PCM.

e) Remove Motor (4) screws and slide the Motor shaft out of the Fuel Supply Pump taking care not to damage the Fuel Supply Pump seal. Note the Motor drive gear size and location for reassembly.

f) Remove the Air Compressor gear retaining snap ring and gear. Inspect gears and replace if necessary. If gears are worn out it is not necessary to replace compressor (spin and check for mechanical interference).

g) Remove Air Compressor (2) screws, Air Compressor, (2) O-rings and the gear locating snap ring from the Air Compressor shaft.

h) Install new Air Compressor; ensure that the O-ring and seats are clean and dry. Assembly lubricant not required.

i) Reinstall gear locating snap ring, gear and gear retaining ring.

j) Reinstall the Motor, with drive gear, take care to ensure that the Fuel Pump seal is not damaged.

k) Reinstall the PCM, blower, blower retaining snap ring, Air Compressor filter and blower housing.

l) Reconnect the Motor, Fuel Shut-off Valve and Ignition Module connectors at the PCM.

m) Test the Air Compressor. Adjust if necessary to correct pressure setting. *Go to items 'i', 'j' and 'k' in Test Procedure – Air Compressor pressure, page 3-12.*

n) Reinstall the flame shield and ignition electrode assembly to the PCM.

o) Reinstall the burner head by mounting it against the heat exchanger face, turning clockwise to engage the mounting ears on the bolts.

p) Reinstall electrical harnesses and fuel supply line.

q) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If a Start diagnostic code is indicated, proceed to Step 7.

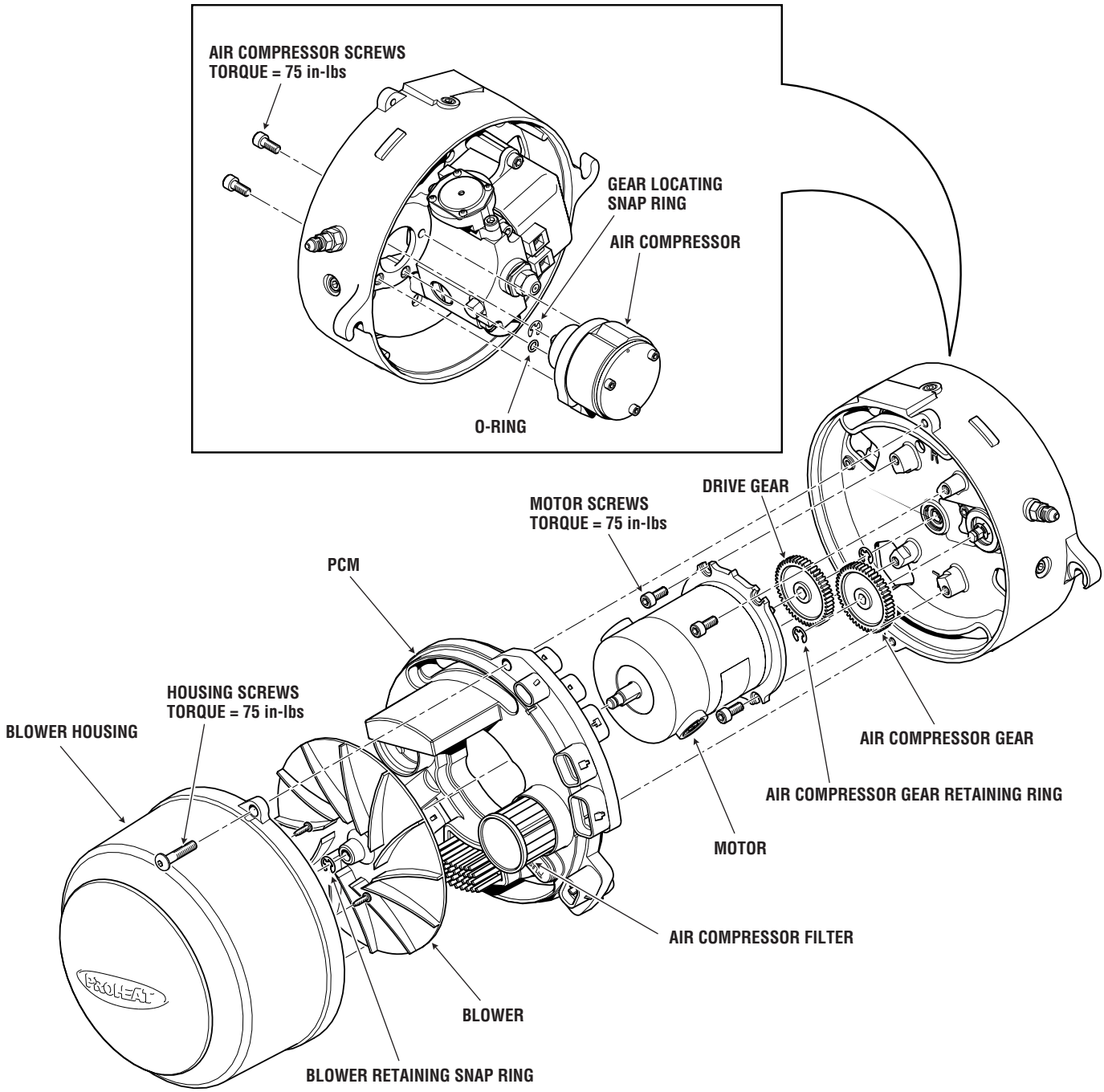


Figure 3-15: Air Compressor Replacement

START: Fuel System Step 7

(1 Flash)

Fuel Supply Pump – Check:

a) Fuel Supply Pump pressure and operation.

Test Procedure – Fuel Supply Pump pressure:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Remove ignition electrode assembly. Use a flat head screwdriver to pry the electrode assembly out.

e) Remove the flame shield. Rotate to match the mounting square.

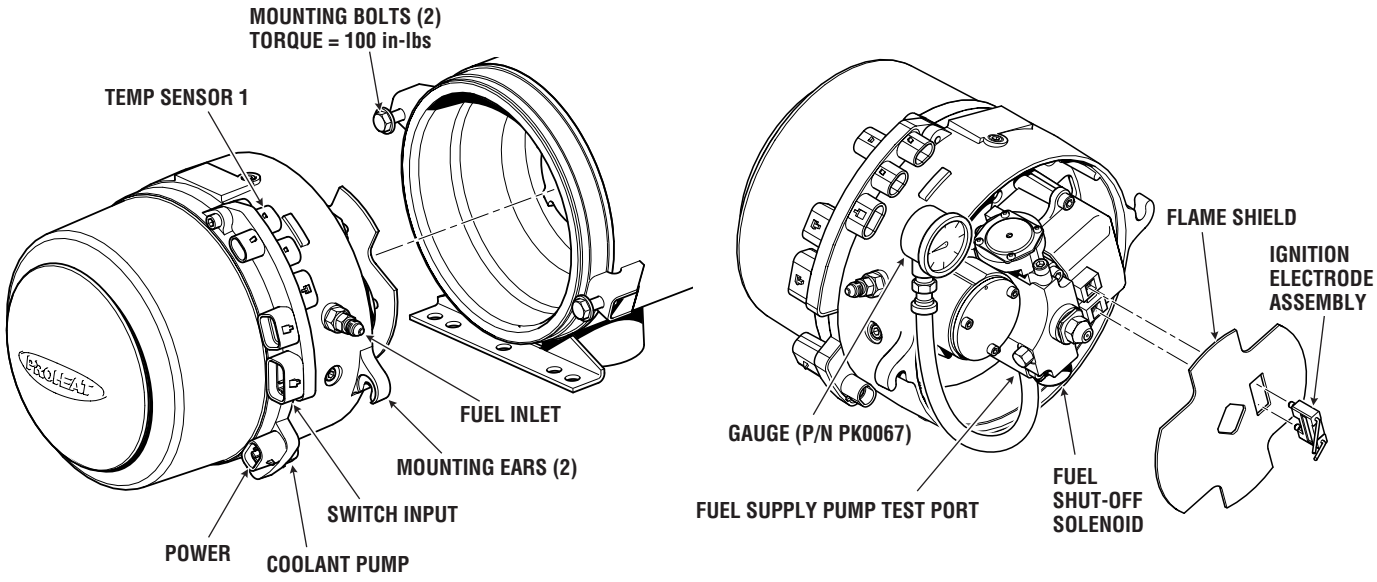


Figure 3-16: Burner Head Removal and Fuel Pressure Test

⚠ WARNING

Flammable.

⚠ WARNING

To avoid the risk of shock and to ensure that the PROHEAT does not fire, disconnect the Ignition Module connector at the PCM.

NOTICE

Leaving the Temperature Sensor(s) disconnected ensures that the burner head will enter purge mode and run for a maximum of three minutes.

f) Disconnect the Fuel Shut-off Valve and Ignition Module connectors at the PCM. Ensures that fuel will not spray and/or light during testing.

g) Remove the Fuel Supply Pump test port plug and install test gauge.

h) Reconnect the power and switch harnesses at the PCM.

i) Reconnect the fuel supply line.

j) Switch the PROHEAT on and read the fuel pressure (should be 3 – 12 PSI):

If the pressure is out of range, Go to Fuel Supply Pump cleaning, page 3-16.

If the pressure reads OK, review Fuel System troubleshooting, page 3-3.

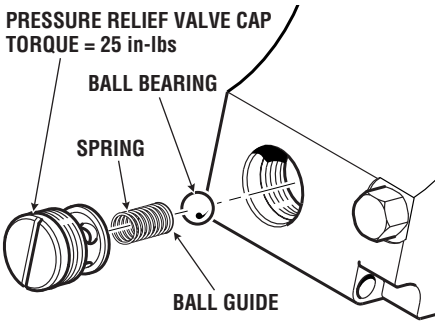


Figure 3-17: Pressure Relief Valve Cap

Fuel Supply Pump cleaning:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Locate the pressure relief valve cap and remove with a slot screwdriver. Careful not to lose any of the internal components that may fall out.

e) Remove the spring from the cavity.

f) Remove the ball bearing from the cavity.

g) Inspect and clean all components.

h) Inspect and clean the cavity. Pay close attention to the center hole in the cavity for any debris or a damaged edge. The edge of the hole should be smooth with no nicks, do not use any tool that may damage this edge as this will cause loss of fuel pressure.

i) Place ball bearing back in cavity on the center hole.

j) Place spring back in hole with brass ball guide on top of ball bearing.

k) Install pressure relief valve cap.

l) Re-test the Fuel Supply Pump. *Start from item 'e' in Test procedure – Fuel Supply Pump pressure, page 3-15.*

If the Fuel Supply Pump pressure tests OK, go to item 'm'.

If the Fuel Supply Pump pressure is still incorrect, go to Fuel Supply Pump replacement

m) Reassemble the burner head.

n) Reinstall electrical harnesses and fuel supply line.

o) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

Fuel Supply Pump replacement:

a) Disconnect and remove the Ignition Module. *Go to page 3-19.*

b) Remove Fuel Nozzle. *Go to page 3-6.*

c) Remove Fuel Regulator. *Go to page 3-11.*

d) Disconnect and remove Fuel Shut-off Valve. *Go to page 3-8.*

e) Remove blower housing (2) screws and blower housing.

f) Remove blower retaining snap ring and slide the blower off the Motor shaft.

g) Disconnect the Motor connector at the PCM. Remove the PCM.

h) Remove Motor (4) mounting screws using a 4 mm Allen wrench.

i) Remove the Motor.

j) Remove the Air Compressor gear retaining snap ring and gear.

k) Remove Air Compressor (2) screws, Air Compressor, (2) O-rings from the Fuel Supply Pump.

l) Reinstall all components in reverse order to new Fuel Supply Pump.

m) Reinstall the burner head by mounting it against the heat exchanger face, turning clockwise to engage the mounting ears on the bolts.

n) Reinstall electrical harnesses and fuel supply line.

o) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

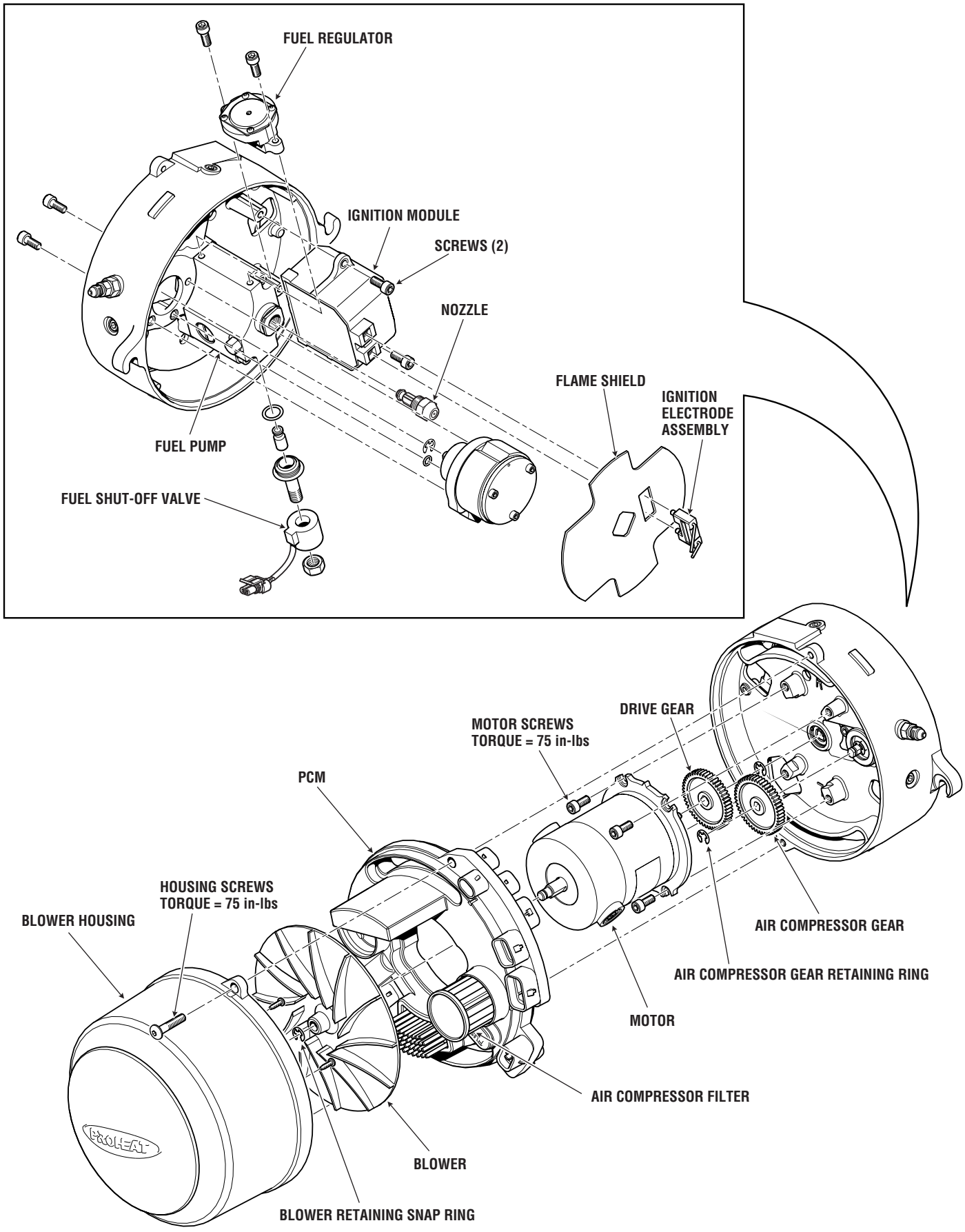


Figure 3-18: Fuel Supply Pump Removal

START: Ignition System

(1 Flash)

Ignition Module – Check:

a) Ignition Operation using Ignition mode.

b) Ignition Module and PCM – electrical open circuit fault.

⚠ WARNING

Do not connect Temperature Sensor to avoid flame.

⚠ WARNING

Shock hazard due to high voltage.

Test Procedure – Ignition service diagnostic:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Check Electrodes for carbon bridging and/or damage. Replace if necessary.

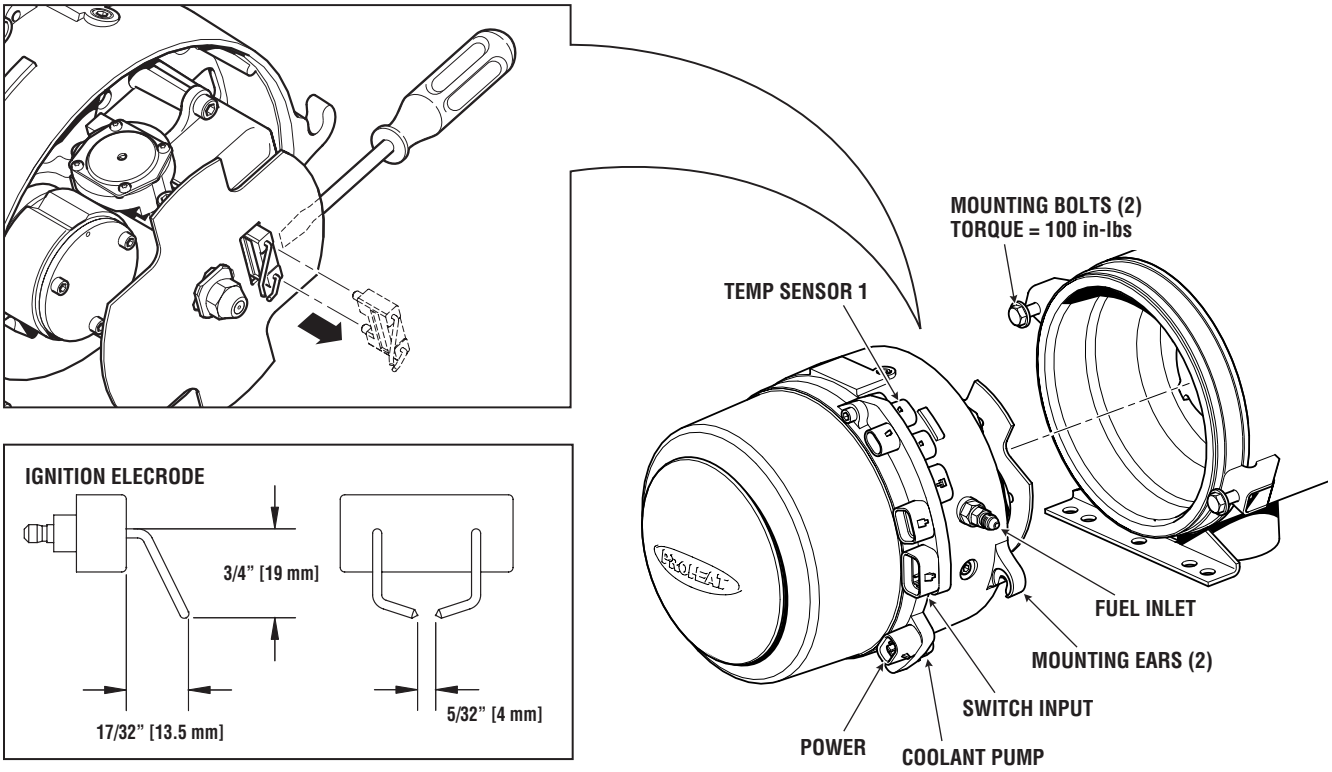


Figure 3-19: Burner Head Removal and Ignition Electrode Removal

⚠ WARNING

Keep blower housing on to avoid injury when Motor starts up.

e) Reconnect the power and switch harnesses.

f) Switch the PROHEAT on and observe for a spark. Spark will continue for five seconds.

If the spark is OK, reinstall the burner head and review Fuel System troubleshooting, page 3-3.

If there is no spark check PCM ignition output voltage.

Test Procedure – PCM ignition output voltage:

a) Disconnect the Ignition Module and the Fuel Shut-off Valve connectors (ensure no flow) at the PCM.

b) Reconnect all external harnesses at the PCM.

c) Switch the PROHEAT on and measure across pins A and C of the PCM Ignition Module connection.

If the correct system voltage (12 or 24) is measured, then measure across pins A and B (should read system voltage during ignition).

If both of the measurements are correct, then replace Ignition Module. Go to Ignition Module replacement.

If either of these measurements are incorrect, the PCM is faulty. Go to PCM replacement, page 3-39.

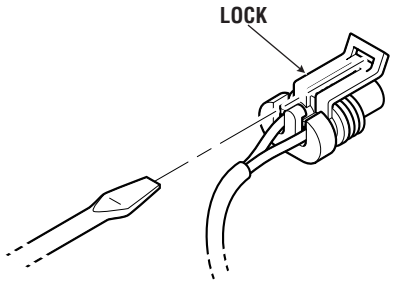


Figure 3-20: Connector Removal

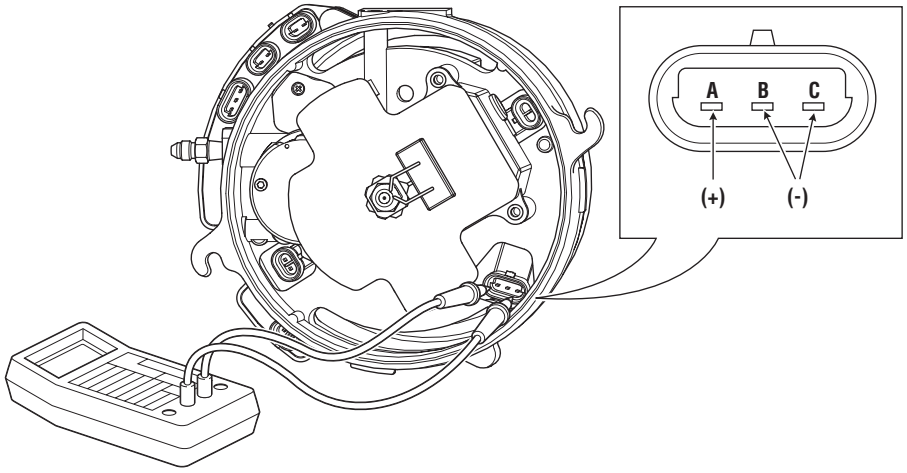


Figure 3-21: PCM Ignition Module Connection Measurement

Ignition Module replacement:

a) Remove ignition electrode assembly. Use a flat head screwdriver to pry the electrode assembly out.

b) Remove the flame shield. Rotate to match the mounting square.

c) Remove Ignition Module (2) mounting screws and Module.

d) Reinstall the new Ignition Module.

e) Reinstall flame shield and electrode assembly.

f) Reconnect Ignition Module connector at the PCM.

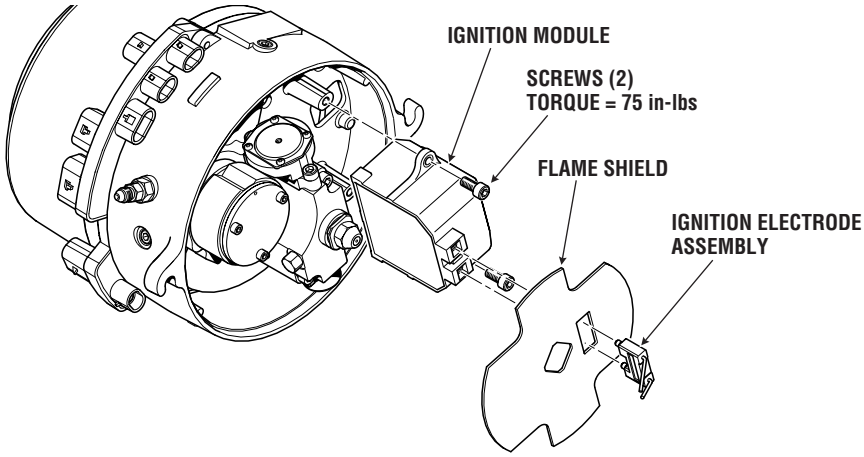


Figure 3-22: Ignition Module Replacement

START: PCM Flame Sensor Circuit *(1 Flash)*

Flame Sensor – Check:

a) Flame Sensor operation.

b) Combustion tube orientation.

Test Procedure – Flame Sensor circuit:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back off the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

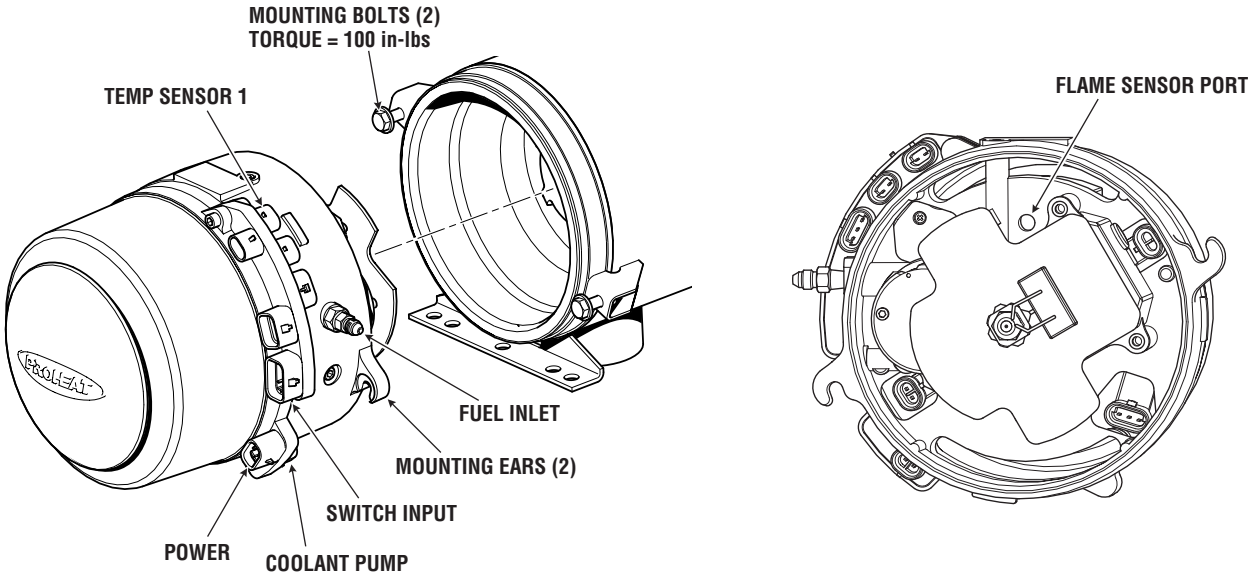


Figure 3-23: Burner Head Removal and Flame Sensor Location

⚠ WARNING

To avoid the risk of shock and to ensure that the PROHEAT does not fire, disconnect the Ignition Module connector at the PCM.

d) Disconnect the Ignition Module connector at the PCM.

e) Check for contamination on the Flame Sensor. Clean if necessary using electrical contact cleaner or warm soapy water.

f) Reconnect the power harness and the remote test switch with the switch in the off position.

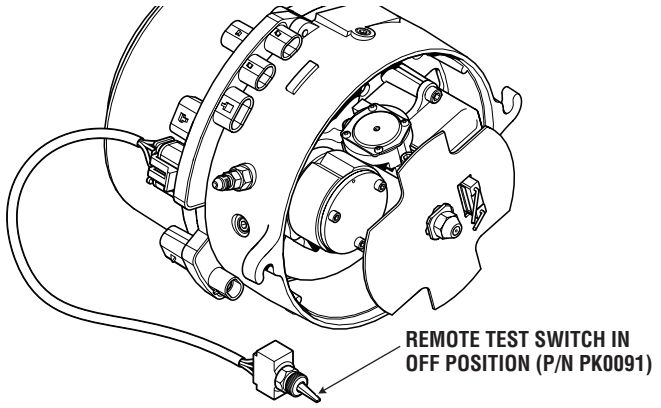


Figure 3-24: Remote Test Switch Connection

g) Place a finger over the sensor port located on the burner head flange. The indicator light should go out. Remove your finger and shine a flashlight into the sensor, the indicator light should come on.

If the indicator light reacts correctly, the Flame Sensor is OK. Go to Test Procedure – Combustion Tube orientation.

If the indicator light does not react, the Flame Sensor is faulty. Go to PCM replacement, page 3-39.

Test Procedure – Combustion Tube orientation:

a) Ensure that the combustion tube orientation boss is aligned with the heat exchanger flange notch.

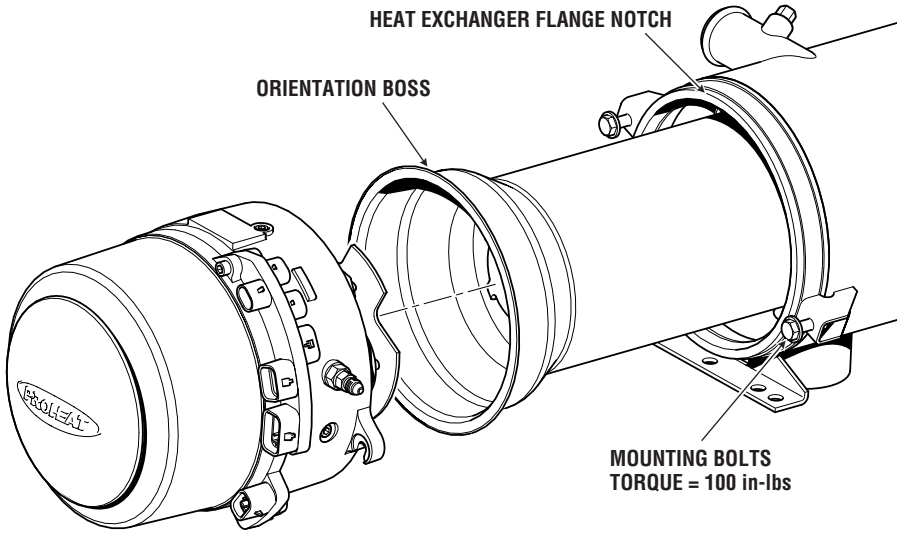


Figure 3-25: Combustion Tube Orientation

START: Motor and/or PCM fault *(1 Flash)*

Motor or PCM – Check:

a) Electrical function – Open circuit motor.

b) Electrical function – Open circuit PCM.

⚠ CAUTION

DO NOT connect Motor directly to batteries or another power source as it will damage the Motor.

Test Procedure – Open circuit Motor:

a) Disconnect the Motor connector at the PCM.

b) Using a multimeter set for resistance (Ohms) measure across pins A and B.

c) Check for an open circuit.

If and open circuit is detected, go to Motor replacement, page 3-23.

If an open circuit is not detected, go to Test Procedure – Open circuit PCM.

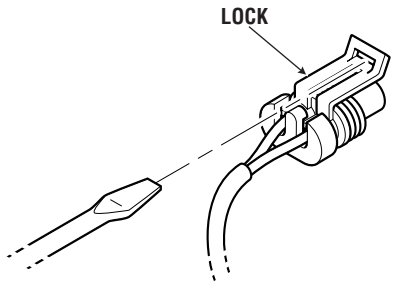


Figure 3-26: Connector Removal

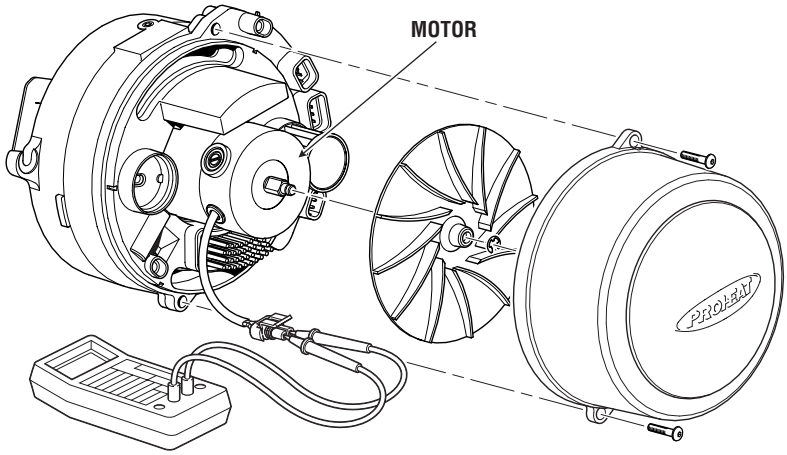


Figure 3-27: Motor Electrical Resistance Measurement

Test Procedure – Open circuit PCM:

a) Disconnect the Motor connector and Temperature Sensor 1 at the PCM.

b) Reconnect the power and switch harnesses at the PCM.

c) Switch the PROHEAT on and measure voltage across pins A and B of the PCM Motor connection.

If the correct nominal system voltage (12 or 24) is measured, the PCM is OK. Go to Test Procedure – Open circuit Motor.

If no voltage is measured, the PCM is faulty. Go to PCM replacement, page 3-39.

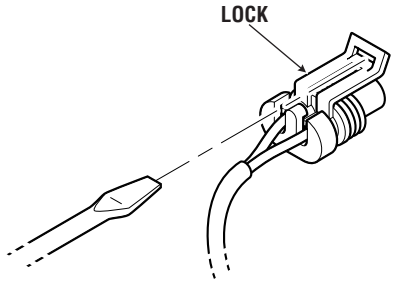


Figure 3-28: Connector Removal

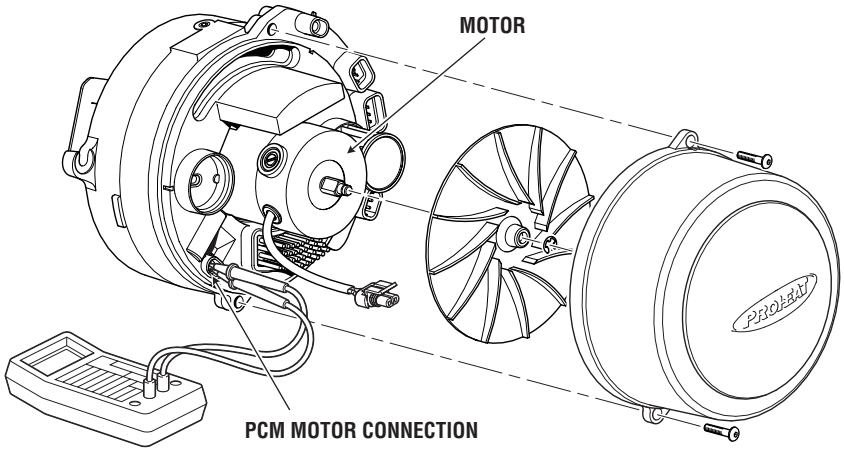


Figure 3-29: PCM Motor Output Voltage Measurement

Motor replacement:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Remove blower housing (2) screws and blower housing.

e) Remove blower retaining snap ring and slide the blower off the Motor shaft.

f) Disconnect the Motor connector at the PCM.

g) Remove Motor (4) mounting screws using a 4 mm Allen wrench.

h) Remove the Motor. Take care when removing that the Fuel Supply Pump seal is not damaged.

i) Remove the gear retaining snap ring and gear from the old Motor and install on the new Motor.

j) Install the new Motor. Take care when installing the Motor shaft in the Fuel Supply Pump seal. Lubricate with clean diesel fuel.

k) Reinstall (4) screws.

l) Reconnect the Motor connector at the PCM.

m) Reinstall the blower, blower retaining snap ring, Air Compressor filter and blower housing.

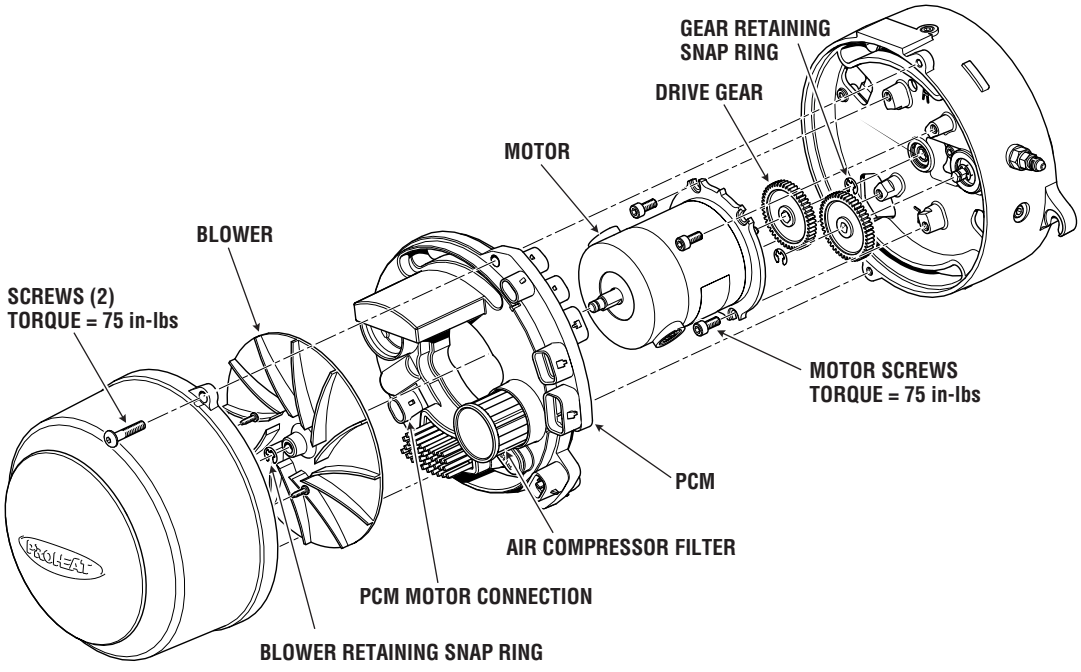


Figure 3-30: Motor Replacement

3.1.2 FLAME OUT Diagnostic Code

(2 Flashes)

Indicates that a flame was detected but it could not be maintained or after being established the flame went out before reaching the cycle off temperature of 185°F (85°C).

Flame Out sequence:

a) A flame is detected during the Ignition period or during Full Output.

b) The flame goes out.

c) The ignition is switched on for a maximum of 10 seconds to try and reestablish the flame (Ignition periods will be 10 seconds longer in cases where the Flame Out occurred during the Ignition period).

d) If the flame is not established the Flame Out diagnostic code is displayed.

A Flame Out diagnostic code distinguishes that:

a) A flame was detected therefore there was a spark and the Ignition system works.

b) The flame was detected therefore the Flame Sensor works.

c) The fault is in the fuel supply system.

Troubleshoot the Flame Out diagnostic code based on:

1. **Fuel supply to the PROHEAT.** *Go to page 3-4 and 3-5, Steps 1 and 2.*
   - Fuel tank pick-up.
   - Fuel fittings.
   - Fuel lines.
   - OEM supplied filters and check valves.
2. **PROHEAT fuel system.** *Go to page 3-6 to 3-15, Steps 3 to 7.*
   - Fuel Supply Pump
   - Air Compressor
   - Fuel Regulator
   - Fuel Shut-off Valve
3. **Operational symptoms that may occur in conjunction with a Flame Out code.** *Go to pages 3-4 to 3-15, Steps 1 to 7.*
   - Combustion hesitation or coughing.
   - Backfiring.
   - Smoke.
   - Strong diesel fuel odor.

3.1.3 COOLANT FLOW Diagnostic Code

(3 flashes)

Indicates that the coolant temperature in the PROHEAT reached 185°F (85°C) within 90 seconds from the beginning of Ignition. There is coolant in the system but its flow rate is too low.

Troubleshoot the Coolant Flow diagnostic code based on:

1. **Vehicle coolant system.** *Go to Step 1.*
   - The PROHEAT starts and runs for 90 seconds or less and shuts down with a Coolant Flow diagnostic code indicated.
2. **Coolant Pump system electrical or mechanical fault.** *Go to Step 2.*
   - The PROHEAT starts and runs for 90 seconds or less and shuts down with a Coolant Flow diagnostic code indicated.

COOLANT FLOW: Step 1 — Vehicle coolant system – Check:

(3 Flashes)

⚠ WARNING

NEVER remove coolant lines when the engine is hot – escaping steam or scalding water could cause serious personal injury. Loosen the coolant line clamps slowly, allowing the pressure to escape before removing completely.

a) For restrictions and blockages in the coolant lines.

b) OEM system shut-off valves for correct operation.

c) For loose hose clamps – air introduced into the system.

d) Coolant line size, fittings. Are they too restrictive?

e) Direction of flow. Are the PROHEAT Coolant Pump and the engine Coolant Pump pumping in the same direction when they are operating at the same time?

f) Coolant capacity. Is there enough coolant in the system? *Go to Technical Specifications, page 1-1.*

g) PROHEAT location. Is the PROHEAT or Coolant Pump the high point in the system? Coolant Pumps are not self-priming and a surge tank may be required.

COOLANT FLOW: Step 2 — Coolant Pump and PCM – Check:

(3 Flashes)

a) PCM electrical function.

b) Coolant Pump electrical function.

c) Coolant Pump mechanical function.

Test Procedure – Electrical:

a) Disconnect the Coolant Pump connector at the PCM.

b) Using a multimeter set for voltage, switch the PROHEAT on and measure across pins A and B on the PCM Coolant Pump connection.

If the correct nominal system voltage (12 or 24) is measured, the PCM is OK. Go to Procedure – Mechanical inspection and testing, page 3-26.

If no voltage is measured, the PCM is faulty. Go to PCM replacement, page 3-39.

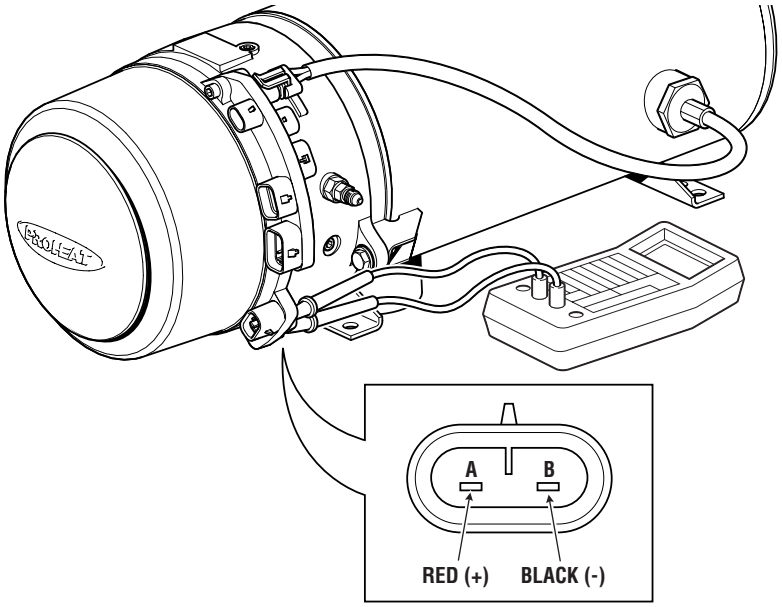


Figure 3-31: PCM Coolant Pump Output Voltage Measurement

⚠ WARNING

NEVER remove coolant lines when the engine is hot – escaping steam or scalding water could cause serious personal injury. Loosen the coolant line clamps slowly, allowing the pressure to escape before removing completely.

Procedure – Mechanical inspection and testing:

a) Connect the power directly to the Coolant Pump. Observe the operation.

If the Motor does not operate, replace the Coolant Pump.

3.1.4 OVERHEAT Diagnostic Code

(4 Flashes)

Indicates that the Temperature Sensor detected an inner heat exchanger surface temperature of 230°F (110°C) within 60 seconds after entering Cool Down.

Troubleshoot the Overheat diagnostic code based on:

1. **Lack of coolant, air or flow problems in the coolant system.** *Go to page 3-25, Steps 1 and 2.*
2. **Faulty Temperature Sensor.** *Go to page 3-29.*
3. **Faulty PCM Temperature Sensor circuit.** *Go to page 3-29.*

To reset the PROHEAT, switch it off and then on again.

⚠ CAUTION

Repeatedly resetting the PROHEAT without resolving the Overheat diagnostic code will damage the heat exchanger.

3.1.5 VOLTAGE Diagnostic Code

(5 Flashes)

Indicates that the supply voltage to the PCM is outside the operating range.

Operating Range:

- 12 volt PROHEAT – 10 to 15 volts.
- 24 volt PROHEAT – 20 to 30 volts.

Troubleshoot the Voltage diagnostic code based on:

1. **Low voltage.**
   - Voltage supply is below the rated requirement.
   - Poor or faulty electrical connections.
   - Voltage supply source is OK. Voltage drop due to high amperage load while the PROHEAT is operating or trying to operate.
2. **High voltage.**
   - Voltage supply is above the rated requirement while the vehicle engine is running.

VOLTAGE: Step 1 — High Voltage – Check:

(5 Flashes)

The vehicle charging system. Consult the OEM for service requirements.

VOLTAGE: Step 2 — Low Voltage – Check:

(5 Flashes)

a) System voltage supply source.

b) Wiring harnesses and connection points.

Procedure – Low voltage testing:

a) Inspect the wiring harnesses and connections for corrosion and proper fit. Clean if necessary.

b) Using a multimeter set for voltage, measure across the positive and negative battery terminals or at the supply source.

If the voltage is below the required voltage, service the batteries and/or charging system as per OEM supplier recommendations.

If the voltage level is within the operating range, go to item 'c'.

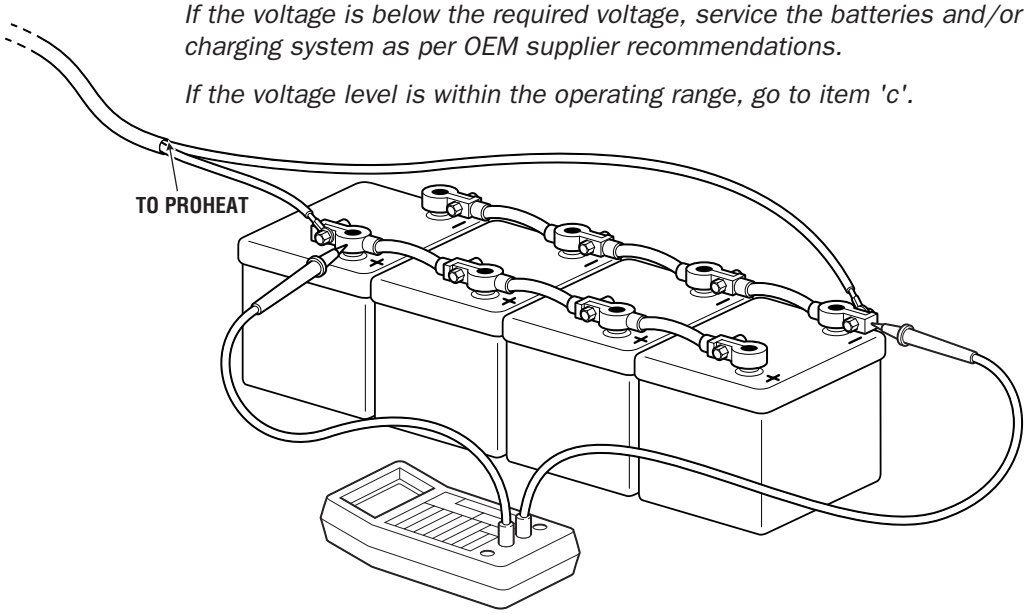


Figure 3-32: Voltage Measurement

c) Locate and measure across pins D and B in the PCM Data Link connection. Perform this with the PROHEAT off and then switched on.

If the voltage is within the operating range and a Voltage diagnostic code is indicated, the PCM is faulty. Go to PCM replacement, page 3-39.

If the voltage falls below the required voltage when the Motor starts, check the wiring from the supply source to the PROHEAT PCM. Go to page 3-22.

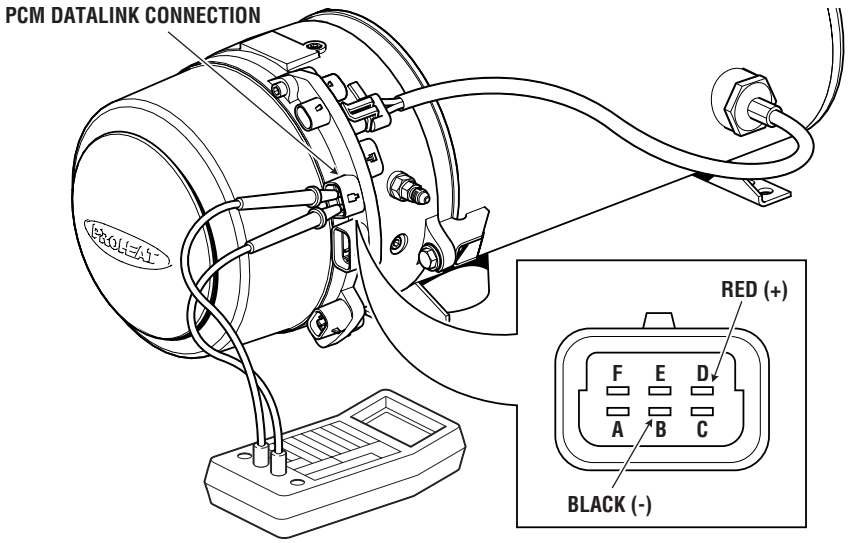


Figure 3-33: PCM Datalink Connection

3.1.6 FLAME FAULT Diagnostic Code

(6 Flashes)

Indicates that:

1. The PROHEAT reached 185°F (85°C) cycled off and entered Cool Down. After 20 seconds a flame was still detected.
2. The PROHEAT was switched on and a flame (signal) was detected in Pre-check.

Troubleshoot the Flame Fault diagnostic code based on:

1. **Fuel System fault.** *Go to pages 3-6 to 3-15, Steps 3 to 7.*
2. **PCM Flame Sensor circuit.** *Go to page 3-20.*

3.1.7 TEMPERATURE SENSOR T1 Diagnostic Code

(7 or 9 Flashes)

Indicates an electrical fault in the Temperature Sensor.

Troubleshoot the Temperature Sensor diagnostic code based on:
Whether the PROHEAT is equipped with a single Temperature Sensor or dual Temperature Sensors.

TEMP SENSOR T1: Step 1

(7 or 9 Flashes)

Temperature Sensor and PCM (single sensor) – Check:

a) Temperature Sensor and PCM electrical function.

Test Procedure – Sensor and PCM:

a) Remove Temperature Sensor connector from PCM connection T1.

b) Remove the PCM sealing plug from PCM connection T2. Put sealing plug into PCM connection T1.

c) Reconnect the Temperature Sensor connector to PCM connection T2.

d) Switch the PROHEAT on:

If a diagnostic code is indicated, the sensor is faulty. Go to Temperature Sensor replacement.

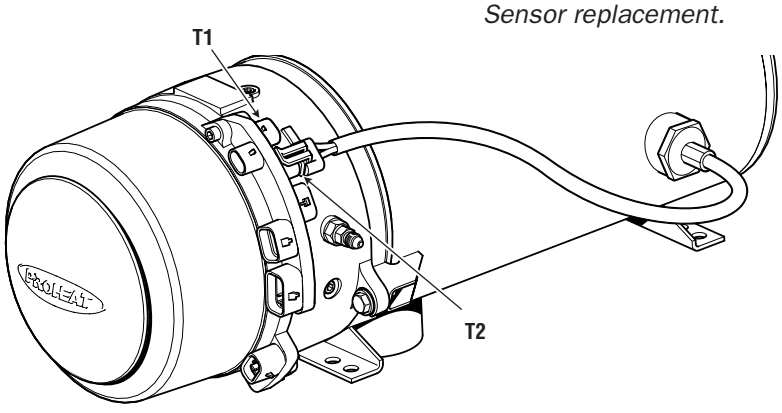


Figure 3-34: Temperature Sensors

If after changing the Temperature Sensor a diagnostic code is still indicated, the PCM is faulty. Go to PCM replacement, page 3-39.

If a diagnostic code is not indicated, the PCM T1 circuit is faulty. It is NOT necessary to change the PCM. The PROHEAT may be used with the Temperature Sensor T2 circuit if only one sensor is required. Leave the Temperature Sensor connected to PCM connection T2 and operate the PROHEAT as normal.

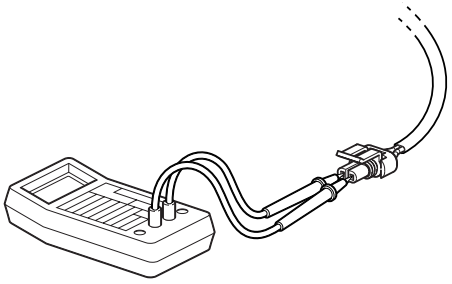


Figure 3-35: Temperature Sensor Test

Test Procedure – Temperature Sensor measurement:

a) Using a multimeter set for resistance, measure across pins A and B of the sensor.

If the sensor measures out of range (see chart below), the sensor is faulty. Go to Temperature Sensor replacement.

TEMP (C)	TEMP (F)	OHMS (±4%)	TEMP (C)	TEMP (F)	OHMS (±4%)
-30	-22	2108926.1	45	113	41312.0
-25	-13	1527456.0	50	122	33618.4
-20	-4	1117735.9	55	131	27508.9
-15	5	826007.0	60	140	22629.3
-10	14	616199.9	65	149	18710.5
-5	23	463853.2	70	158	15546.6
0	32	352205.6	75	167	12978.9
5	41	269657.2	80	176	10884.8
10	50	208103.2	85	185	9168.8
15	59	161828.4	90	194	7756.1
20	68	126766.5	95	203	6587.9
25	77	100000.0	100	212	5617.8
30	86	79417.9	105	221	4808.8
35	95	63481.0	110	230	4131.4
40	104	51058.1			

TEMP SENSOR T1: Step 2

(7 or 9 Flashes)

Temperature Sensor and PCM electrical (dual sensors) – Check:

a) Temperature Sensor and PCM electrical function.

Test Procedure – Sensor and PCM:

a) Remove Temperature Sensor connector from PCM connection T1.

b) Remove Temperature Sensor connector from PCM connection T2.

c) Swap the connectors. T1 to T2 and T2 to T1.

d) Switch the PROHEAT on:

If a Temperature Sensor T1 diagnostic code is now indicated, the sensor is faulty. Go to Temperature Sensor replacement.

If a Temperature Sensor T2 diagnostic code is still indicated, the PCM is faulty. Go to PCM replacement, page 3-39.

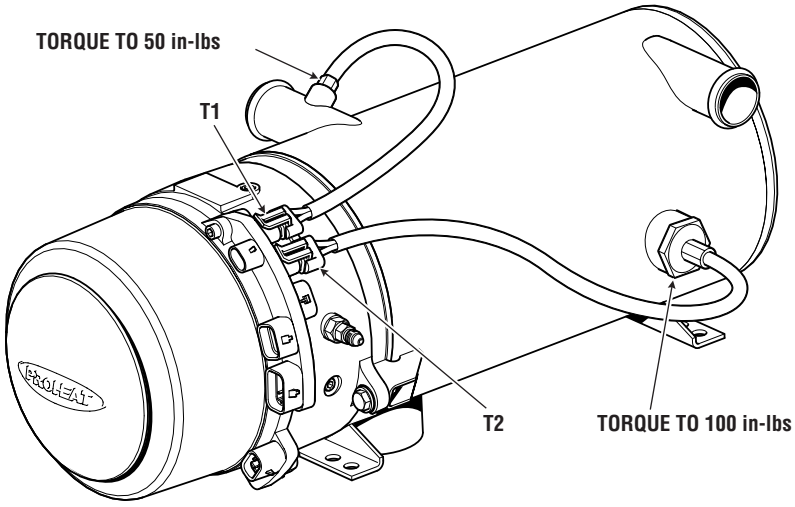


Figure 3-36: Temperature Sensors

⚠ WARNING

NEVER remove coolant lines when the engine is hot – escaping steam or scalding water could cause serious personal injury. Loosen the coolant line clamps slowly, allowing the pressure to escape before removing completely.

Temperature Sensor replacement:

a) Isolate the coolant system at the PROHEAT inlet and outlet ports for minimal coolant loss using valves in the system or hose clamps.

b) Remove sensor using a 14 mm wrench.

c) Reinstall the new sensor. Ensure that the O-ring and O-ring seat are clean. Install the sensor until it bottoms out on the mounting boss.

3.1.8 FUEL SHUT-OFF VALVE Diagnostic Code

(8 Flashes)

Indicates an electrical fault in the Fuel Shut-off Valve coil or in the PCM Fuel Shut-off Valve circuit.

Troubleshoot the Fuel Shut-off Valve diagnostic code based on:
Fuel Shut-off Valve Coil or PROHEAT PCM electrical.

Test Procedure – Fuel Shut-off Valve and PCM test:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Disconnect the Fuel Shut-off Valve connector at the PCM.

e) Disconnect the Ignition Module connector at the PCM

f) Reconnect the power, Temperature Sensor(s) and switch harnesses at the PCM.

g) Switch the PROHEAT on:

If a Fuel Shut-off Valve diagnostic code is NOT indicated and the PROHEAT attempts to operate, the Fuel Shut-off Valve is faulty. Go to Fuel Shut-off Valve replacement, page 3-10.

If the Fuel Shut-off Valve diagnostic code is still indicated, the PCM is faulty. Go to PCM replacement, page 3-39.

⚠ WARNING

To avoid the risk of shock and to ensure that the PROHEAT does not fire, disconnect the Ignition Module connector at the PCM.

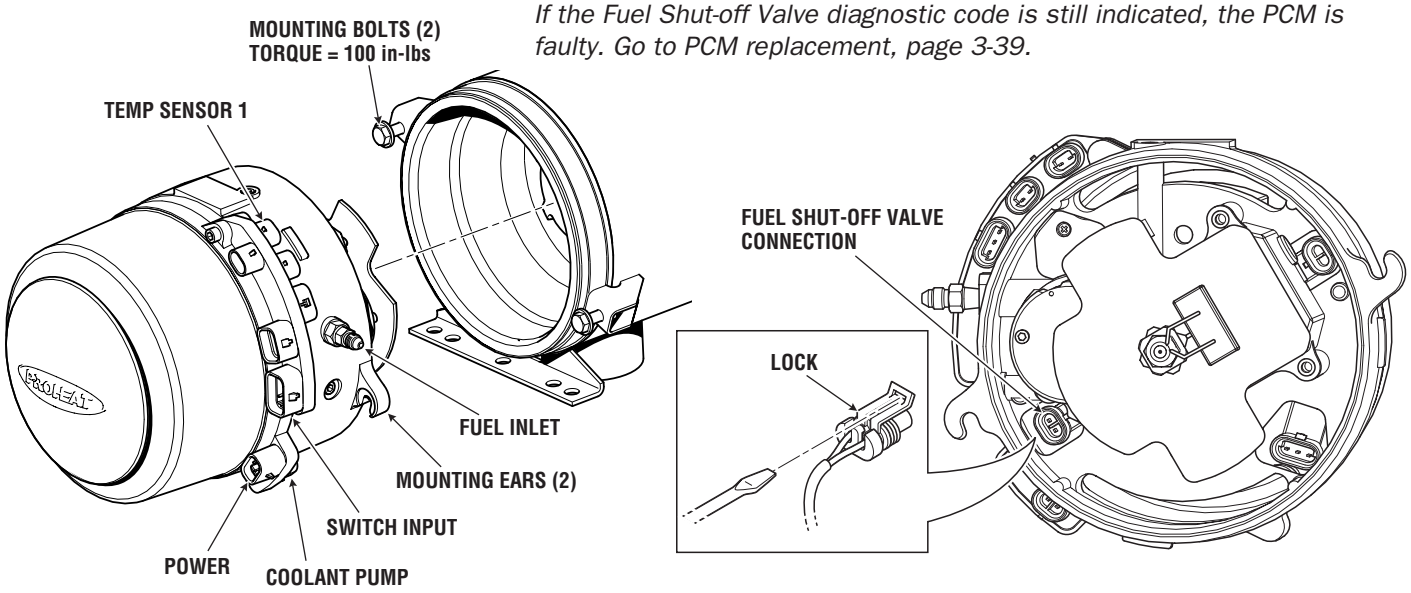


Figure 3-37: Burner Head Removal and Fuel Shut-off Valve Connection

3.1.9 TEMPERATURE SENSOR T2 Diagnostic Code

(7 or 9 Flashes)

Go to Temperature Sensor T1 Diagnostic Code, page 3-29.

3.1.10 IGNITION MODULE Diagnostic Code

(10 Flashes)

Indicates an over-load fault is detected.

Troubleshoot the Ignition Module diagnostic code based on:
Ignition Module and PCM – electrical.

Test procedure – Ignition Module and PCM:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Disconnect the Ignition Module connector at the PCM.

e) Reconnect the power and switch harnesses at the PCM.

f) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If an Ignition Module diagnostic code is NOT indicated and the PROHEAT attempts to operate, the Ignition Module is faulty. Go to Ignition Module replacement, page 3-19.

If the Ignition diagnostic code is indicated, the PCM is faulty. Go to PCM replacement, page 3-39.

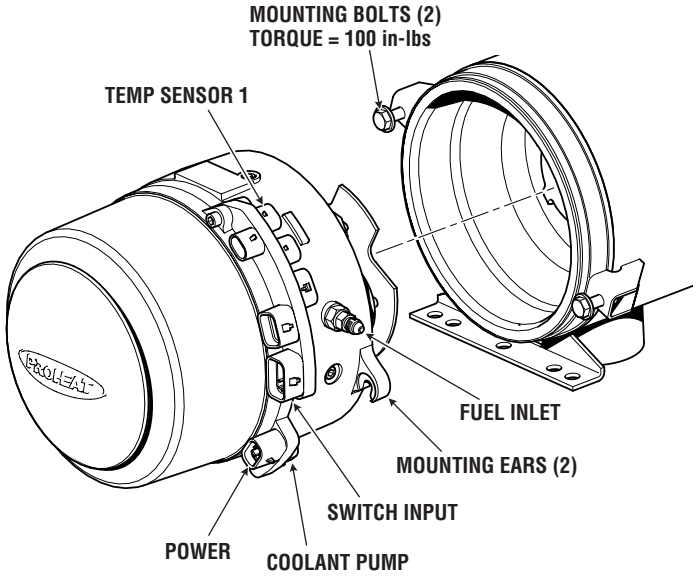


Figure 3-38: Burner Head Removal

3.1.11 COOLANT PUMP Diagnostic Code

(11 Flashes) Indicates an over-load fault is detected.

Troubleshoot the Coolant Pump diagnostic code based on:
Coolant Pump and PCM – electrical.

Test Procedure – Coolant Pump and PCM test:

a) Disconnect the Coolant Pump at the PCM.

b) Switch the PROHEAT on and observe for a diagnostic code.

If a Coolant Pump diagnostic code is NOT indicated and the PROHEAT operates, the Coolant Pump is faulty. Go to Coolant Pump replacement.

If the Coolant Pump diagnostic code is still indicated, the PCM is faulty. Go to PCM replacement, page 3-39.

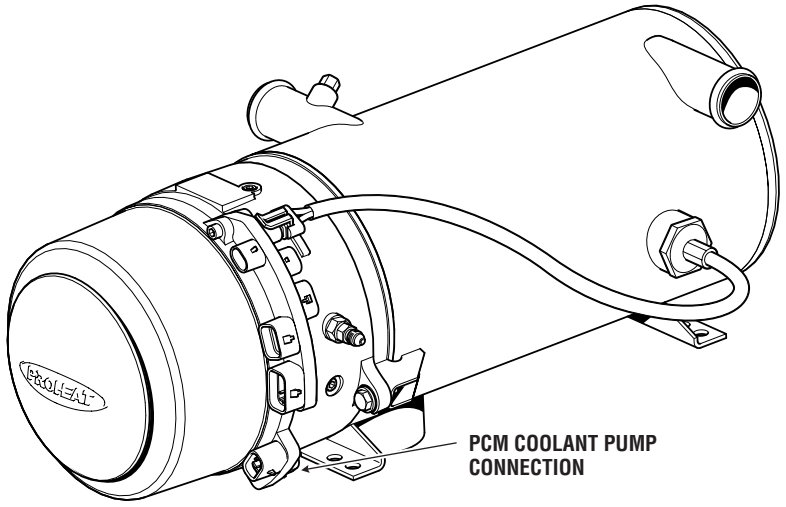


Figure 3-39: PCM Coolant Pump Connection

⚠ WARNING

NEVER remove coolant lines when the engine is hot – escaping steam or scalding water could cause serious personal injury. Loosen the coolant line clamps slowly, allowing the pressure to escape before removing completely.

Coolant Pump replacement:

a) Isolate the Coolant Pump using shut-off valves provided in the coolant system or hose to minimize coolant loss.

b) Remove Coolant Pump.

c) Install new Coolant Pump.

⚠ CAUTION

Before starting the PROHEAT ensure that the Coolant Pump is flooded with coolant by opening all valves and running the engine until the air has been purged from the system (approximately 15 – 20 minutes). This will prevent Coolant Pump damage.

3.1.12 MOTOR Diagnostic Code

(12 Flashes) Indicates that an over-load fault is detected in precheck or during operation.

Troubleshoot the Motor diagnostic code based on:

1. Motor – mechanical.
2. Motor or PCM – electrical.

Test Procedure – Motor mechanical function:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Remove blower housing (2) screws and blower housing.

d) By hand, rotate the blower and feel for mechanical binding.

If mechanical interference is felt, isolate the Motor from the Fuel Supply Pump and Air Compressor by removing the Motor. Go to Motor replacement, page 3-23.

If the Motor spins freely and there are no obvious mechanical problems, check the Motor/PCM electrical operation. Go to Test Procedure – PCM Motor output voltage.

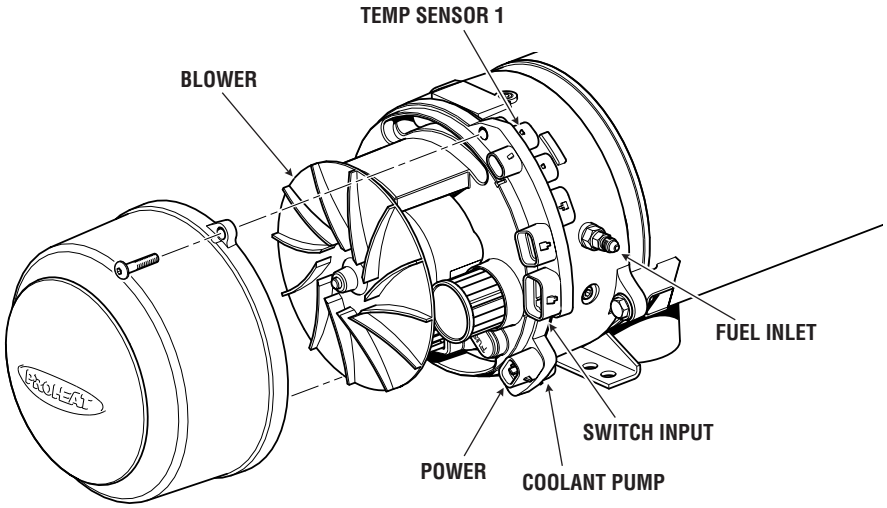


Figure 3-40: Motor Mechanical Check

Test Procedure – PCM Motor output voltage:

a) Disconnect the Motor connector at the PCM.

b) Reconnect the power and switch harnesses at the PCM.

c) Switch the PROHEAT on.

If Motor diagnostic code is still indicated, PCM is faulty. Go to PCM replacement, page 3-39.

If Motor diagnostic code is no longer indicated, Motor is faulty. Go to Motor replacement, page 3-23.

3.1.13 AUXILIARY OUTPUT Diagnostic Code

(13 Flashes)

Indicates a short circuit fault in the harness or the device being operated by the Auxiliary Output.

Troubleshoot the Auxiliary Output diagnostic code based on: PCM – electrical

Test procedure – PCM Output Signal:

a) Disconnect the Auxiliary Output harness at the PCM.

b) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

If the diagnostic code is not indicated the fault is in the harness or the driven device. Go to OEM for service requirements.

If the diagnostic code is still indicated, the PCM is faulty. Go to PCM replacement, page 3-39.

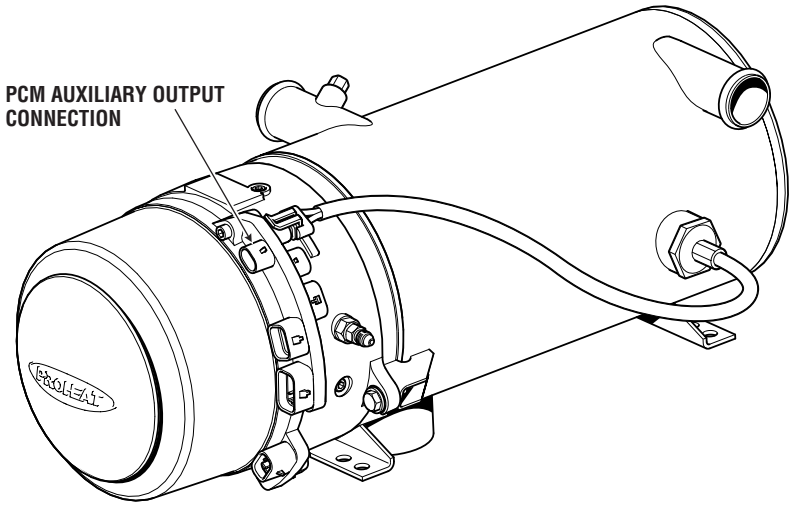


Figure 3-41: Auxiliary Output Connector

3.1.14 SWITCH/TIMER POWER Diagnostic Code

(14 Flashes)

Indicates a short circuit fault in harness or the device being operated by the Switch Output.

Troubleshoot the Switch/Timer Power diagnostic code based on:
Electrical switch circuit in the switch wiring.

Test procedure electrical, short circuit:

a) Remove the Switch Output harness at the PCM.

b) Remote start the PROHEAT using the PROHEAT remote start switch (PROHEAT P/N PK0091).

If the PROHEAT functions correctly, the fault is in the wiring from the PROHEAT back to the switch. See OEM recommended service requirements.

If the PROHEAT does not function, the PCM is faulty. Go to PCM replacement, page 3-39.

3.2 COMPONENT MECHANICAL OR ELECTRICAL PROBLEMS

3.2.1 Fuel Nozzle *Go to page 3-6, Step 3.*

3.2.2 Fuel Shut-off Valve *Go to page 3-8, Step 4.*

3.2.3 Fuel Regulator *Go to page 3-11, Step 5.*

3.2.4 Air Compressor *Go to page 3-12, Step 6.*

3.2.5 Fuel Supply Pump *Go to page 3-15, Step 7.*

3.2.6 Ignition Electrodes *Go to page 3-18.*

3.2.7 PCM Fuse

Protects the PCM against high current. When switched on, the PROHEAT will NOT start, attempt to start, or indicate a diagnostic code.

Troubleshoot a Blown Fuse based on:

1. Voltage supply to the PROHEAT.
2. Voltage at the output connections of the PCM.

Test Procedure – Voltage supply:

a) Disconnect the power harness at the PCM.

b) Using a multimeter set for voltage, measure across pins A and B of the harness connector for system voltage.

If there is no voltage, check the OEM voltage supply. Consult OEM for service requirements.

If the correct voltage (system voltage 12 – 24) is measured, go to item 'c'.

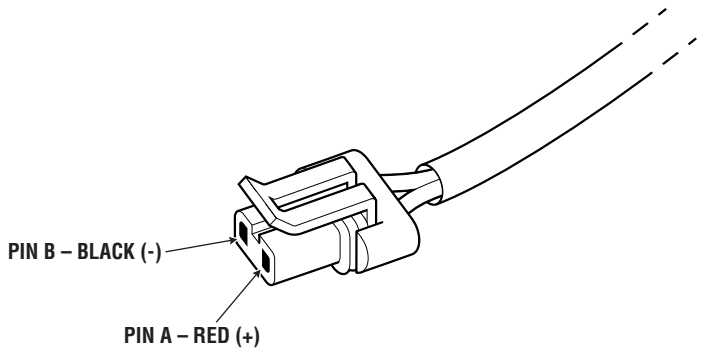


Figure 3-42: Power Harness

c) Disconnect the Datalink harness at the PCM. Using a multimeter set for voltage, measure across pins D and B in the PCM Datalink connection.

If voltage is read and it is of the correct value, the fuse is OK.

If voltage is not present, check the PCM fuse.

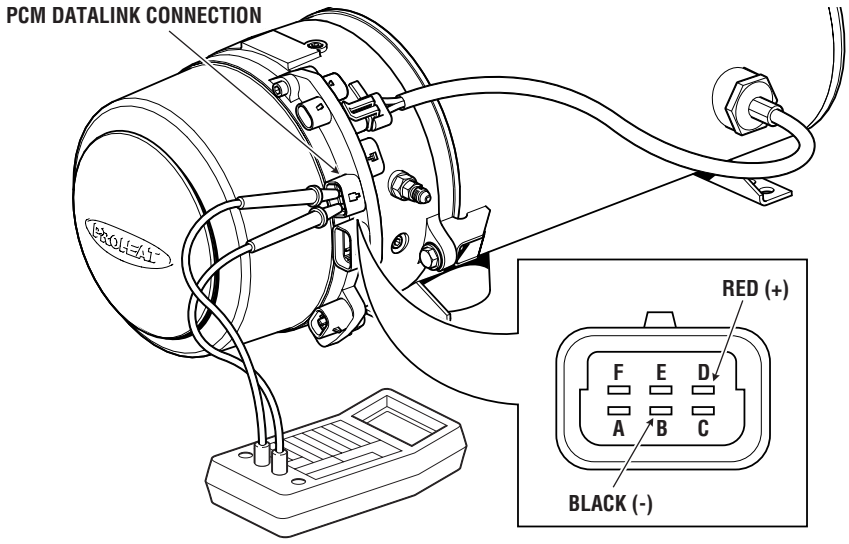


Figure 3-43: PCM Datalink Connection

Procedure – PCM fuse replacement:

a) Disconnect all harnesses at the PCM.

b) Disconnect the fuel supply line.

c) Loosen and back out the burner head mounting (2) bolts five to six turns allowing enough room to rotate the burner head 15° counter-clockwise and remove.

d) Remove blower housing (2) screws and blower housing.

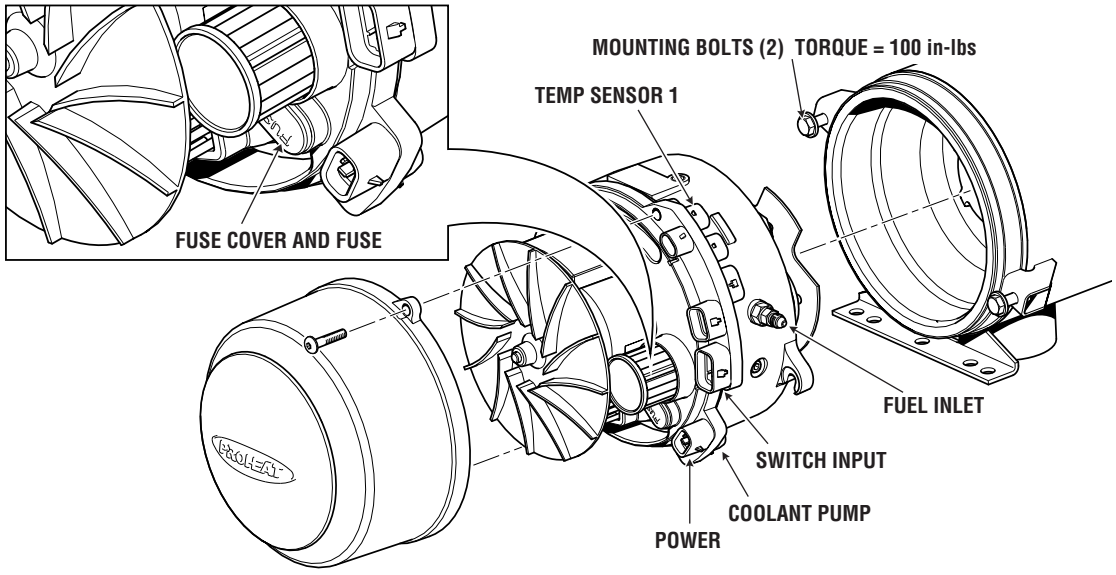


Figure 3-44: Burner Head Removal and Motor Mechanical Check

e) Remove the fuse cover and using needle nose pliers or a fuse removal tool remove the fuse.

If the fuse is blown, replace the fuse and check the PROHEAT current draw. Go to page 3-27.

If the fuse is OK, the PCM is faulty. Go to PCM replacement.

PCM replacement:

a) Disconnect the Fuel Shut-off Valve and Ignition Module connectors at the PCM.

b) Remove the blower housing (2) screws and blower housing.

c) Remove the blower retaining snap ring and slide the blower off the Motor shaft.

d) Remove the Air Compressor filter.

e) Disconnect the Motor connector at the PCM. Remove the PCM.

f) Reinstall the new PCM following items 'e' back to 'a'.

g) Reconnect the burner head by mounting it against the heat exchanger face, turning it clockwise to engage the mounting ears on the bolts.

h) Reconnect electrical harnesses and fuel supply line.

i) Switch the PROHEAT on and operate for at least one complete cycle. Observe the operation.

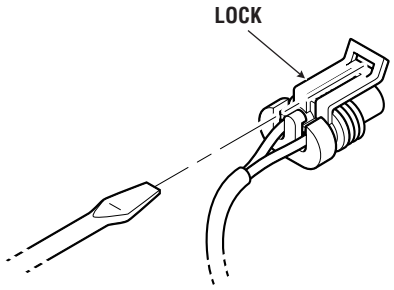


Figure 3-45: Connector Removal

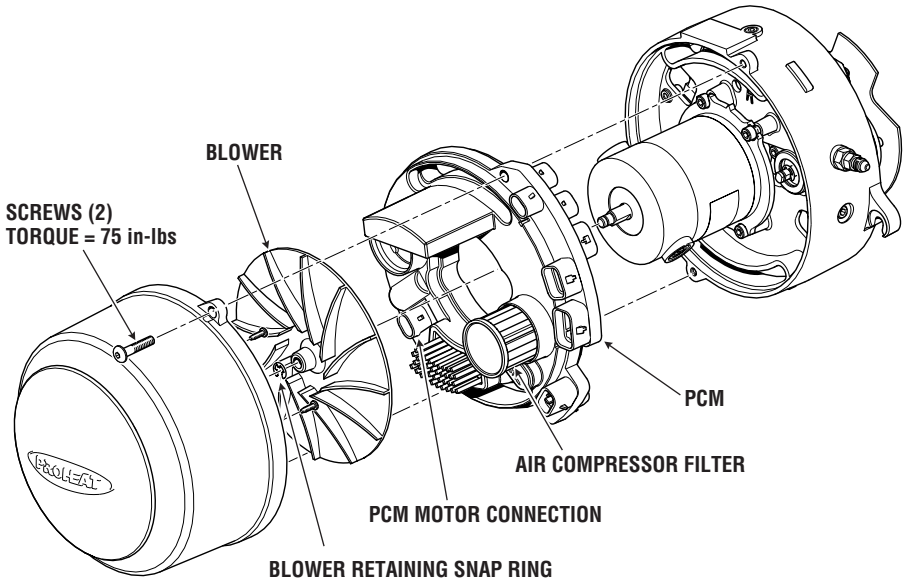


Figure 3-46: PCM Replacement

3.3 OPERATIONAL PROBLEMS

Problems with the PROHEAT and/or vehicle application that are not specifically defined but are observed during the operation of the PROHEAT and or vehicle coolant system. These fall into three categories:

1. **Fuel Supply/Combustion.** *Go to page 3-4 to 3-15, Steps 1 to 7.*
   - Smoke from the exhaust
   - Excessive raw diesel odor.
   - Backfiring and coughing during the combustion process.
   - Low heat output.
2. **Coolant system.** *Go to page 3-25, Steps 1 and 2.*
   - Short combustion cycles. The PROHEAT is turning on and off at very short intervals.
   - Low heat output in the vehicle system. *Go to pages 3-4 to 3-15, Steps 1 to 7.*
3. **Power system.** *Go to pages 3-29 and 3-30, Steps 1 and 2.*
   - Intermittent PROHEAT operation.
   - PROHEAT continues to run when not switched on.

4.0 MAINTENANCE

The following maintenance recommendations are based on the minimum maintenance required. Adjustments to this recommendation are determined by the end user based on:

- Environmental conditions
- Operating hours

Annually:

- Inspect and clean around the PROHEAT and exhaust system.
- Inspect and clean external electrical connectors.
- Test run the PROHEAT, letting it cycle at least once. *Go to page 3-4, Sequence of Operation.*

Observe:

1. **Combustion process.**
   - For smoke and raw fuel odor from the exhaust pipe.
   - Fuel system leaks and corrosion.
   - *If there is a problem go to pages 3-4 to 3-15, Steps 1 to 7.*
2. **Coolant system:**
   - For leaks
   - For correct system heating process. *Go to page 3-25, Steps 1 and 2.*
3. **Power supply system:**
   - For correct operation of the PROHEAT.

Filters:

1. **Fuel filter.** *Go to page 3-5, Step 2.*
2. **Air filter.** *Go to page 3-13, Step 6.*

Combustion chamber:

1. Remove the burner head and inspect the combustion tube and chamber for carbon build up. Clean as necessary using a wire brush.
2. Inspect and clean exhaust system. Ensure that the piping is not damaged.
3. Inspect and clean the ignition electrodes as necessary. *Go to page 3-18.*
4. Inspect and clean the flame sensor as necessary. *Go to page 3-20.*

⚠ WARNING

Shock hazard due to voltage.

Batteries:

Inspect and clean PROHEAT connections at the battery if applicable.

5.0 MAINTENANCE TOOLS

Minimum recommended tools.

1. PROHEAT remote switch (P/N PK0091)
2. Multimeter

Repair tools required:

- 4 mm – Allen wrench
- 5 mm – Allen wrench
- Small flat head screw driver
- 5/8” wrench for nozzle removal
- Wire brush
- Standard wrench set

PROHEAT Serial Number:

Installation Date:

Dealer:

Teleflex®
ENERGY
POWERSYSTEMS

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